AFGL-TR-88-0269

TECHNICAL SUPPORT FOR OPTICAL TURBULENCE RESEARCH

FRANK C. REGAN, JR.

Systems Integration Engineering, Inc.
35 Bedford Street, Suite 12
Lexington, MA 02173

26 September 1988

Final Report
6 March 1985 - 31 August 1988

Approved for public release: distribution unlimited

AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AFB, MASSACHUSETTS 01731-5000

"This technical report has been reviewed and is approved for publication"

JAMES H. BROWN
Contract Manager

DONALD E. BEDO
Branch Chief

FOR THE COMMANDER

R. EARL GOOD
Division Director

This report has been reviewed by the ESD Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS).

Qualified requestors may obtain additional copies from the Defense Technical Information Center. All others should apply to the National Technical Information Service.

If your address has changed, or if you wish to be removed from the mailing list, or if the addressee is no longer employed by your organization, please notify AFGL/DAA, Hanscom AFB, MA 01731. This will assist us in maintaining a current mailing list.

Do not return copies of this report unless contractual obligations or notices on a specific document requires that it be returned.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

ADA204776

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS None
2a. SECURITY CLASSIFICATION AUTHORITY N/A	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release distribution unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Final TR-0052-001	5. MONITORING ORGANIZATION REPORT NUMBER(S) AFGL-TR-88-0269
6a. NAME OF PERFORMING ORGANIZATION Systems Integration Engin. 6b. OFFICE SYMBOL (If applicable) N/A	7a. NAME OF MONITORING ORGANIZATION Air Force Geophysics Laboratory
6c. ADDRESS (City, State and ZIP Code) 35 Bedford Street, Suite 12 Lexington, MA 02173	7b. ADDRESS (City, State and ZIP Code) Hanscom AFB, Massachusetts 01731-5000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable) OPA	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER F19628-85-C-0052
8c. ADDRESS (City, State and ZIP Code) Same as 7b	10. SOURCE OF FUNDING NOS. PROGRAM ELEMENT NO.: 62101F PROJECT NO.: 317J TASK NO.: 1C WORK UNIT NO.: AB
11. TITLE (Include Security Classification) Technical Support for Optical Turbulence	

12. PERSONAL AUTHOR(S)
Frank C. Regan, Jr.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Yr., Mo., Day)	15. PAGE COUNT
Final	FROM 3-6-85 TO 8-31-88	88-09-26	108

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB. GR.	Systems Engineering; Fabrication, Optical Turbulence. (edc)

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report documents technical support provided to ~~the~~ AFGL's Atmospheric Optics Branch of AFGL during the 43 months of contract number F19628-85-C-0052. Specific tasking areas in this contract include the following:

- System Integration,
- Testing,
- Field Support,
- Printed Circuit Board Fabrication,
- Analysis and Design,
- Documentation [illegible] Radiosondes, Thermosondes, Atmospheric [illegible]

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL James H. Brown	22b. TELEPHONE NUMBER (Include Area Code) (617)377-4412 22c. OFFICE SYMBOL AFGL/OPA

DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

TABLE OF CONTENTS

List of Appendices

1.0 INTRODUCTION

On 6 February 1985, Systems Integration Engineering, Inc. (S.I.E.) was awarded a competitive contract to provide supplies and technical services to the Air Force Geophysics Laboratory (AFGL). Purchasing Contract Officer for this effort was Mr. John L. Nunziato and the Laboratory Contract Manager was Mr. James H. Brown, AFGL/OP. The contract was initially awarded for a 36 month effort and modification P00010 extended the period of performance for an additional 7 months at no cost to the Government.

Specific tasks in the contract include the following:

- CLIN 0001 - Test, trim, calibrate, assure performance of 200 Government furnished thermosonde units. Modify and integrate 200 Government radiosondes with 200 Government furnished thermosondes. Deliver integrated assemblies.

- CLIN 000[illegible] Design first article test and acceptance plan, per[illegible] article test/demonstration, prepare developme[illegible].

- CLIN 0003 - Fabricate or acquire 250 radiosondes/240 thermosonde circuit boards, cables and housing assemblies, 600 thermosonde fine wire probes, housing assemblies, and 480 radiosonde batteries. Test, electrically trim, calibrate and assure performance of thermosonde units. Modify and integrate 240 radiosondes with thermosondes and deliver flight-ready payloads.

- CLIN 0004 - Perform engineering design to provide 25 special research radiosonde/thermosonde balloon payloads per year, for a total of 75.

- CLIN 0005 - Provide engineering field support to prepare, checkout, troubleshoot, and ensure performance of 100 radiosonde/thermosonde payloads per year.

- CLIN 0006 - Perform engineering design to improve sonde performance, correct problems, enhance reliability, and lower costs.

- CLIN 0007 - Delivery of descriptive data. SIE has submitted quarterly Research and Development Reports which document progress in each of the specified task areas.

The purpose of this Final Technical Report is to summarize all progress in the above task areas. To accomplish this purpose, the remainder of this report will address each task using the following format:

- Task Description
- Discussion
- Difficulties Encountered
- Status

2.0 TASK DESCRIPTION

CLIN 0001 - Test, trim, calibrate, assure performance of 200 Government furnished thermosonde units. Modify and integrate 200 Government radiosondes with 200 Government furnished thermosondes. Deliver integrated assemblies.

2.1 Discussion

Work on this task began at contract award (6 February 1985). The Government Furnished Equipment (GFE) was tested, trimmed, calibrated and integrated. Final delivery of the units took place at Systems Integration Engineering and is documented by DD 250 number SIE 0001 dated 22 October 1985.

2.2 Difficulties Encountered

No unanticipated difficulties were encountered while completing Task 0001.

2.3 Status

This task was completed according to the terms of contract F19628-85-C-0052 on 22 October 1985.

3.0 TASK DESCRIPTION

CLIN 0002 - Design first article test and acceptance plan, perform first article test/demonstration, prepare test report.

3.1 Discussion

The purpose of this task was to assure the quality of the SIE production units and to review SIE fabrication and testing procedures. Work on this task began in October 1985. Deliveries under CLIN 0002 were as follows:

Deliverable	Delivery	Acceptance
First Article Test and Acceptance Plan	October 1985	December 1985
First Article Test	December 1985	December 1985
First Article Test/ Demonstration Report	December 1985	January 1986

Completion of this task is documented by DD250, number SIE 0002, dated 5 February 1986. A copy of the First Article Test and Acceptance Plan is attached as Appendix A to this report. Appendix B is a copy of the First Article Test/Demonstration Report submitted in December 1985.

3.2 Difficulties Encountered

No unanticipated difficulties were encountered while completing Task 0002.

3.3 Status

This task was completed according to the terms of contract F19628-85-C-0052 on 22 October 1986.

4.0 TASK DESCRIPTION

CLIN 0003 - Fabricate or acquire 250 radiosondes/240 thermosonde circuit boards, cables and housing assemblies, 600 thermosonde fine wire probes, housing assemblies, and 480 radiosonde batteries. Test, electrically trim, calibrate and assure performance of thermosonde units. Modify and integrate 240 radiosondes with thermosondes and deliver flight ready payloads.

4.1 Discussion

The purpose of this task is to fabricate or acquire the various components needed to measure optical turbulence and integrate these components into flight ready payloads. Initially this CLIN called for the acquisition or fabrication of 300 radiosondes, 300 thermosonde boards with cables and housing assemblies, and 600 thermsonde fine wire probes with housing assemblies. Budgetary constraints forced the Government to reduce the number of radiosondes, thermosondes and batteries. This reduction is documented in contract modification P00009 dated 1 July 1987. Work on this task began in September 1985. Deliveries under CLIN 0003 are as follows:

Date	DD250	Delivery
7 April 1986	SIE 0003	20 Radiosondes 20 Thermosondes with cables and housing 40 Fine wire probes with housings 40 Radiosonde batteries
22 August 1986	SIE 0004	80 Radiosondes 80 Thermosondes with cables and housing 160 Fine wire probes 160 Radiosonde batteries
25 November 1986	SIE 0005	50 Radiosondes 50 Thermosondes with cables and housing 100 Fina wire probes 100 Radiosonde batteries

5 February 1988	SIE 0008	100 Radiosondes 90 Thermosondes with cables and housing 300 Fine wire probes 180 Radiosonde batteries

4.2 Difficulties Encountered

The only unanticipated difficulty encountered while completing Task 0003 was the reduction in quantities due to the non-availability of funding. Because the Laboratory Contract Manager provided sufficient notice to the contractor, the reduction in funding had no adverse impact on the contractor's effort in this task area.

4.3 Status

This task was completed according to the terms of contract F19628-85-C-0052 (modification P00009 on 5 February 1988).

5.0 TASK DESCRIPTION

CLIN 0004 - Perform engineering design to provide 25 special research radiosonde/thermosonde balloon payloads per year, for a total of 75.

5.1 Discussion

The purpose of this task was to configure various payloads for Air Force Geophysics Laboratory system research.

Under this task, SiE configured a number of different payloads to investigate methods of improving the performance of the optical turbulence measurement system. Several of the payload configurations used in the investigation are summarized below:

Purpose	Configuration
Investigate the effects of solar radiation on fine wire probe performance.	Several probes were painted with solar white paint. Other probes were painted black, Striped or covered with foil and, in some instances, the probes were physically replaced with resistors.
Investigate the effects of balloon wake on system performance.	Several payloads were configured with unusually long (300-400 foot) cord trains separating the payload from the balloon. Measurements, taken in this configuration were compared to those of a standard configuration to determine the effects of balloon wake turbulence.
Investigate the effect of Automatic Gain Control (AGC) on overall system performance.	Several AGC's were disabled or modified and resulting data compared with data using the standard configuration.
Investigate temporal resolution of thermosonde data.	Circuit was modified to set the initial condition to zero at the start of each sampling interval.

Determine the temperature profile of the Optical Turbulence Payload.	Thermistors were attached at various points on several payloads and temperature data was telemetered to the ground station.
Provide a more accurate pressure profile of the payload flight.	A pressure sensor board was designed, built and calibrated in a vacuum chamber for future flight. The pressure sensor board description, schematic and parts list is included as appendix C to this report.

Data obtained from the above investigations were retained by the Air Force Geophysics Laboratory.

Work on this task began in March 1985. Deliveries under CLIN 0004 were as follows:

Date	DD250	Delivery
4 September 1987	SIE 0006	43 Units
10 December 1987	SIE 0007	32 Units

5.2 Difficulties Encountered

No unanticipated difficulties were encountered while completing Task 0004.

5.3 Status

This task was completed according to the terms of contract F19628-85-C-0052 on 10 December 1987.

6.0 TASK DESCRIPTION

CLIN 0005 - Provide engineering field support to prepare, checkout, troubleshoot and ensure performance of 100 radiosonde/thermosonde payloads per year.

6.1 Discussion

The purpose of this task was to provide field support to the Air Force Geophysics Laboratory. Included in the field support was the preparation of equipment for use in the field, travel, field launches, limited material purchases to support the field effort and unpacking/storing equipment after field use. During this period SIE prepared, checked out, troubleshot and ensured the performance of all radiosonde/thermosonde payloads launched by the Air Force Geophysics Laboratory either locally or at remote sites.

During calendar year 1985, SIE provided 32.25 man-weeks of field support at White Sands Missile Range, N.M. and Maui, Hawaii, in support of the Critical Laser Enhancing Atmospheric Research (CLEAR) II and III and the Atmospheric Compensation Experiment (ACE) I, II, and III. In calendar year 1986, SIE provided 28.73 man-weeks of field support at Holloman AFB, N.M., at Hanscom AFB, MA, and at Pennsylvania State University. SIE provided 31.56 man-weeks of field support in calendar year 1987 at Sudbury Test Site, MA, Hanscom AFB, MA, Otis AFB, MA, and Holloman AFB, N.M. During calendar year 1988, SIE provided 24.13 man-weeks of field support at Malabar, Florida in support of Malabar Optical Site Evaluation Survey (MOSES) and in Champaign, Illinois.

6.2 Difficulties Encountered

During the performance of this task several difficulties were identified and overcome. During one field trip it became apparent that the thermosonde output was exceeding the threshold input of the radiosonde. After analysis the method of limiting the output voltage of the thermosonde was changed as described in clin 0006 of this report and performance of the payload improved immediately. In Maui Hawaii it was necessary to move the payload launch site to avoid RF interference from a nearby antenna field. Also during this contract a number of radiosondes were found to be defective. This problem was addressed by a transmitter change by the manufacturer and by increased emphasis on incoming quality assurance inspections.

6.3 Status

This task was completed according to the terms of contract F19628-85-C-0052 on 31 August 1988.

7.0 TASK DESCRIPTION

CLIN 0006 Perform engineering design to improve sonde performance, correct problems, enhance reliability and lower costs.

7.1 Discussion

The purpose of this task is outlined in the task description. Work on this task began in March 1985 and continued through September 1987. As a result of this tasking, Systems Integration Engineering has recommended and made several modifications to the original thermosonde boards. These modifications are outlined below:

- Carbon composition resistors, R2, R5, and R63 (5% tolerance) were replaced with precision thin metal film resistors (1% tolerance) reducing susceptibility to temperature gradients and system noise.

- Diode CR3 was changed from a 1N751 to a 1N4689 in the oscillator section. The faster diode solved the problem of rounded edges on the square wave.

- R7 was removed, reducing the sine wave distortion in the oscillator section.

- Winchester Connectors in the probe cables were removed. This resulted in a reduction in cost and labor without compromising thermosonde performance in any way.

- Capacitor C36 was changed from 220 pf to 330 pf providing a better level of frequency compensation. This eliminated high frequency oscillations in the preamplifier.

- The method of output limiting was changed. Previously, supply voltage was limited to a Harris output buffer resulting in an unreliable maximum voltage clamp. SIE removed the Harris chips, which reduced cost, and diode clamped the internal buffer of the RMS convertors with CR9 and CR10, 1N751's. Also, current limiting resistors R82 and R83 were changed from 5.1 to 3.0 ohms to solve resulting turn-on problems.

In addition, SIE revised the existing thermosonde schematic and printed circuit board artwork to reflect the modification to the aesign. The revised thermosonde schematic and printed circuit board artwork are included in this report as Appendix D.

To improve reliability and correct problems sometimes encountered in the field, a complete set of operating and assembly procedures was daveloped and published. These procedures are outlined below:

- Thermosonde Board Inspection and Cleaning Procedures - Appendix E
- Thermosonde Assembly Procedures - Appendix F
- Fine Wire Probe Assembly Procedures - Appendix G
- Thermosonde Signal Cable Assembly Procedures - Appendix H
- Radiosonde Signal Cable Assembly Procedures - Appendix I
- Thermosonde adjustment and Calibration Procedures - Appendix J
- Thermosonde Probe Balancing Procedure - Appendix K

7.2 Difficulties Encountered

No unanticipated difficulties were encountered while completing Task 0006.

7.3 Status

This task was completed according to the terms of contract F19628-85-C-0052 in September 1987.

8.0 TASK DESCRIPTION

CLIN 0007 - Data delivery requirements.

8.1 Discussion

Data requirements are contained in attachment 1 to the contract (Contract Data Requirements List, DD Form 1423, dated 84 May 11).

8.2 Difficulties Encountered

No unanticipated difficulties were encountered while completing Task 0007.

8.3 Status

This task will be completed according to the CDRL attached to contract F19628-85-C-0052 with the acceptance of the Final Technical Report, CDRL number 102.

9.0 SUMMARY

During the forty-three months covered by contract F19628-85-C-0052, Systems Integration Engineering has completed all seven of the assigned tasks. Progress in each of the assigned tasks was documented in Quarterly Reports (CDRL number 101) and all documentation originated by SIE is available for review in the SIE documentation files.

DEPARTMENT OF THE AIR FORCE
AIR FORCE GEOPHYSICS LABORATORY (AFSC)
HANSCOM AIR FORCE BASE, MASSACHUSETTS 01731-5000

REPLY TO ATTN OF: OPA/J. H. Brown/(617)861-3685 17 Dec 85

SUBJECT: Approval of Quarterly Reports - Contract No. F19628-85-C-0052

TO: R. Fries
Systems Integration Engineering, Inc.
Suite 12, The Liberties
35 Bedford St.
Lexington, MA 02173

1. The following report submitted in accordance with the terms of subject contract has been received by this office:

a. Report Number : 1

b. Date of Report: October 1985

c. Periods - From: One Time

d. Title of Report: First Article Test and Acceptance Plan

e. Classification: Unclassified

2. This report is accepted. I concur with the security classification assigned.

REMARKS: Nothing in this letter constitutes a commitment of any type whereby it could form the basis of any future claims against the Government.

James H. Brown

JAMES H. BROWN
Contract Manager
Atmospheric Optics Branch
Optical Physics Division

cc: XOR
ESD/PKR
DAA
ACO/DCASMA
495 Summer St
Boston, MA 02210

A-1

SIE 0052-0002-1

OTS PAYLOAD

FIRST ARTICLE

TEST AND ACCEPTANCE PLAN

October 1985

Prepared By
Systems Integration Engineering, Inc.

R. Fries, Principal Author

Contract No. F19628-85-C-0052
Item No. 0002AA
CDRL No. 201

Prepared For
Optical Physics Division
Air Force Geophysics Laboratory

FOREWORD

This test plan has been prepared in accordance with the instructions in Data Item Description DI-T-30744 as required by CRDL Item 201 of Contract F19628-85-C-0052.

CONTENTS

FIRST ARTICLE TEST & ACCEPTANCE PLAN
OTS PAYLOAD

1.0 TEST OBJECTIVE

The test objective is to provide verification of acceptable performance of a representative Optical Turbulence System (OTS) payload from the first lot of such payloads manufactured/assembled by the contractor.

1.1 Test Item Description

The test item is an integrated, flight-ready OTS payload consisting of the following:

(1) Thermosonde circuit board

(1) Thermosonde housing assembly with cross arm

(2) Probe Holders

(2) Tungsten fine wire probes with housings

(1) Thermosonde aluminum slip-on box

(2) Thermosonde batteries

(1) Digital "locate" radiosonde, modified for use with thermosonde

(1) Complete set of finished cables including ferrite beads on probe cables.

1.2 Reference Documentation

- Northeastern University Dwg. No. 0983 (schematic of Thermosonde electronics, with mods as of Oct. 85)
- Tri-Con Associate Dwg. No. D-4021 (layout of Thermosonde electronics, with mods as of Oct. 85)
- Parts List for Thermosonde (Oct. 85)
- AFGL Dwg. No. LKD 83-1058, Thermosonde Enclosure
- AFGL Dwg. No. GL 83-020 C Rev A, Fine Wire Temp Probe Assembly
- AFGL Dwg. No. GL 82-008 C Rev A, F.W.T.P. Housing Assembly

2.0 TECHNICAL DATA REQUIREMENTS

Technical data are required prior to flight, during flight, and after flight as described below.

2.1 Pre-Flight Data Requirements

- Radiosonde calibration data
- Thermosonde calibration data

2.2 Flight Data Requirements

- Radiosonde pressure sensor data
- Radiosonde thermistor data
- Radiosonde hygristor data
- Radiosonde NAVAID data
- Thermosonde low-gain data
- Thermosonde high-gain data
- Thermosonde reference voltage data

2.3 Post-Flight Data Requirements

- Plots of reduced MET data
- Plots of reduced NAVAID data
- Plots of $C_N{}^2$ data

3.0 TEST PROCEDURES

The overall test includes the following elements:

- Radiosonde check
- Thermosonde adjustment and calibration
- Thermosonde probe balancing
- Payload integration
- Ground station flight checks
- Flight operations
- Post-flight operations

Each of these elements is briefly described below, with supplementary details provided in the appendices.

3.1 Radiosonde Check

The Radiosonde is checked out prior to modification in order to 1) provide confidence that it will perform satisfactorily in flight and 2) avoid the potential waste of effort entailed in modifying an initially unacceptable unit.

The Radiosonde Checklist is provided in Appendix 1. Radiosonde modification is performed in accordance with a detailed SIE procedure.

3.2 Thermosonde Adjustment and Calibration

Thermosonde adjustment and calibration is performed to 1) assure proper operation of the Thermosonde electronics and 2) provide the calibration data required for flight data reduction.

The detailed Thermosonde Adjustment and Calibration Procedure is provided in Appendix 2.

3.3 Thermosonde Probe Balancing

Thermosonde probe balancing is performed to ensure that the Thermosonde electronics used with a particular set of probes is properly balanced prior to flight.

The detailed Thermosonde Probe Balancing Procedure is provided in Appendix 3.

3.4 Payload Integration

A procedure is followed to ensure proper integration of a Thermosonde and Radiosonde into a flight ready payload.

The detailed Payload Integration Procedure is provided in Appendix 4.

3.5 Ground Station Flight Checks

Ground station flight checks are performed to assure proper operation of the integrated payload immediately prior to launch.

The Ground Station Flight Checklist is provided in Appendix 5.

3.6 Flight Operations

Flight operations are those activities which occur between payload launch and final loss of signal. During this interval, data are received, decoded, and displayed in real time, as well as recorded on disk for post-flight data reduction.

3.7 Post-Flight Operations

Post-flight operations consist primarily of data reduction, generation of appropriate plots, and evaluation of results in light of flight conditions and the existing data base.

On this test, payload performance will be considered satisfactory if the results compare favorably with previous results obtained under similar conditions of launch location and launch time. Nominal performance expectations are as follows:

MET data:
- clean P, T, U histories from 0 to 30 km.

C_N^2 data:
- minimum values reach noise curve periodically in troposphere
- relative maximum detected during boundary layer inversion
- data reducible at least 95% of the time that temperature data is nominal

Satisfactory payload performance on this test will constitute demonstration of the contractor's ability to fabricate and integrate flight ready payloads.

4.0 RESPONSIBILITIES OF PARTICIPANTS

Responsibilities of test participants, both Government and contractor, are briefly defined below.

4.1 Government Responsibilities

Government responsibilities consist of the following:

- Provide launch site.
- Provide ground station for tracking and recording flight.
- Provide balloon, helium fill facility, and perform fill.
- Perform ground station pre-flight checks. Launch payload.
- Perform routine post-flight data reduction operations.

4.2 Contractor Responsibilities

- Perform Radiosonde checks.
- Perform Thermosonde adjustment and calibration.
- Perform Thermosonde probe balancing.
- Perform payload integration.
- Provide flight ready payload
- Provide support to Government as required.

APPENDICES

1. Radiosonde Checklist
2. Thermosonde Adjustment and Calibration Procedure
3. Thermosonde Probe Balancing Procedure
4. Payload Integration Procedure
5. Ground Station Flight Checklist

APPENDIX 1

RADIOSONDE CHECKLIST

MICROSONDE S/N ____

MICROSONDE CHECKOUT	YES	NO
1. FLAP SWITCH	___	___
2. Bar Codes = VIZ sheet S/N	___	___
3. Enter pressure bar code, does calibration agree with VIZ	___	___
4. 399 Freq 405	___	___
5. Peak-to-Peak Amp 4 sm div	___	___
6. MET STRING RECEIVED	___	___

Date Completed ________

MICROSONDE MODIFICATION (performed per detailed SIE procedure)

1. OPEN AND INSPECT ___
2. DRILL HOLES FOR CABLE ___
3. SOLDER CABLE TO POINTS ___
4. INSTALL STRAIN RELIEF FOR CABLE ___
5. CLOSE AND SEAL WITH RTV ___

Date Completed ________

APPENDIX 2

THERMOSONDE ADJUSTMENT AND CALIBRATION PROCEDURE

Equipment: One dual output 18 VDC battery pack
One dual trace oscilloscope
One digital volt meter
One Thermosonde calibration box
Assorted cables and connectors

Procedure:

1. Inspect board for damage, broken wires, bad solder joints, etc.

2. Connect calibration box to thermosonde. RES switch should be ON, all other switches should be in the OFF position.

3. Connect battery pack (power off) to Thermosonde.

4. Turn on power-current on each output of the battery pack should be no greater than 100MA.

5. Using the DVM measure the outputs of the voltage regulator U8. The voltages should be:

   a. +15 $\pm$ .75 volts at the junction of pin 2 of U8 and C34.

   b. -15 $\pm$ .75 volts at the junction of pin 7 of U8 and C33.

6. Connect O-scope as follows: channel-1 to pin 10 of U1, channel-2 to pin 12 of U1, AC coupling for both. Trigger internally on channel-2. On channel 1 a sine wave of approx 3 kHz and greater than 6VP-P should be seen. On channel 2 a square wave should be seen with approx the same values.

7. With both signals on the scope adjust R8 until the signals are 180° out of phase.

8. Connect clip lead across C35 (between test points B and E). Turn R43 and R48 fully clockwise. (10 turns).

9. Connect the O-scope to TP-C. The predominant signal at this point should be a 3 kHz sine wave. Some fuzziness due to a SMALL amount of noise and higher frequency components may be present. Adjust R60 to decrease the amplitude (at or below 50 mV is acceptable.)

10. Connect the oscilloscope to test point D. Adjust R24 until the negative peaks of the demodulated 3 kHz signal are of the same amplitude. The waveforms at this point are a series of half sine waves between their 90° and 270° points, interrupted by switching transients.

11. Connect a DVM to test point D. Use 200 (500) mV dc scale and readjust R60 to reduce the dc voltage to fall between $\pm$ 75 mV.

12. Connect the digital voltmeter to the cathode of CR1 and the oscilloscope to test point "C". Adjust R48 while observing the digital voltmeter and the oscilloscope. As Q_1 starts to turn on, the three kilohertz wave at test point C will start to increase. At this point observe the voltage at the cathode of CR2 and adjust R43 in the same manner.

13. Remove the short from C35. Allow time (no more than 2 min) for the circuits to reach a steady state. Using DVM check the output voltages at pins 7 and 14 of U14. The dc signal at pin 7 of U14 (Lo-gain output) should be less than 100mV. Typical readings are in the vicinity of 50mV. The signal at pin 14 of U14 (Hi-gain output) should be less than 300 mV. Typical readings are in the vicinity of 200mV.

14. Turn on the oscillator in the calibration box by moving the OSC switch into UP position. Move R8 and R12 switches into ON (UP) position. Adjust R62 to produce 3.90 volts at pin 7 of U14.

15. Turn the oscillator, R8 and R12 in the calibration box OFF. Allow time (no more than 2 min) for the circuits to settle. Verify the quiescent readings of step 13. Then turn the oscillator R8 and R12 ON. The Lo-gain output (pin 7 of U14) should return to 3.90 volts within 60 seconds.

16. Proceed with the calibration by throwing the appropriate switches ON and OFF as required by the attached "Laboratory Thermosonde Calibration" sheet. Allow at least 60 seconds after any disturbance before recording results.

17. Measure and record to a $\pm$ 1 mV accuracy the voltage (V_{REF}) from the stand off for the WH/OR wire. V ref should read 2.5 $\pm$ .1VPC.

LABORATORY THERMOSONDE CALIBRATION

DATE: ________

MICROSONDE S/N: ______________ V REF: ________

THERMOSONDE S/N: ______________ Rp1= ________

PROBE PAIR: ______________ Rp2= ________

SIMULATED PROBES

Rp= 27.5

ACTUAL PROBES

Rp AVG=______

LO GAIN		HI GAIN	
R#	RMS volts		RMS volts
R 0		R 0	
R 2		R 1	
R 3/2		R 2	
R 4/2		R 3	
R 7		R 3/2	
R 8		R 4	
R 9		R 4/2	
R 10		R 5	
R 11		R 5/2	
R 12		R 6	
R 12/4/2		R 7	
R 12/7		-	
R 12/8		-	

APPENDIX 3

THERMOSONDE PROBE BALANCING PROCEDURE

Equipment: One dual output 18 VDC battery pack
One digital voltmeter (DVM)
One thermosonde battery box (or other small box)
One adjusting tool
Assorted cables

Procedure:

1. Clip probe leads to 1/4" and 5/16". Spread leads slightly to prevent shorting. Remove probe caps and attach to Thermosonde cables. Replace probe caps.
2. Tape probes tightly together and place inside box.
3. With power off connect battery pack to thermosonde.
4. Allow 10-15 minutes for probe temperature to stabilize.
5. Place DVM on TP-D of thermosonde.
6. Apply power to Thermosonde. DVM should register a switch-on voltage gradually decreasing towards zero.
7. Place shorting cable across C35 (TP-B, TP-E).
8. Adjust R60 until DVM registers less than .075VDC. (If voltage "walks" allow more time for probes to stabilize.)*
9. Remove shorting lead from C35.
10. Check voltage at pin 7 of U14. It should stabilize to 100 MVDC or less within one minute.
11. Turn power off and remove DVM and battery cables.
12. Remove probes from the box and tape to thermosonde housing.

* If R60 will not adjust voltage to zero check probe connections for opens or shorts. If none are found check probe resistances. (Nominal probe resistance is 27 ohms.)

APPENDIX 4

Payload Integration Procedure

Equipment: Glue brush
Ty-wrap gun
Assorted hand tools

Material: Rez-N-Glue
Ty-wrap
Duct tape

Procedure:

1. Determine the center of the cross boom and mark it.
2. Center the cross boom on the Thermosonde styrofoam housing. Apply glue to the top of the housing and attach the cross boom by pressing firmly and taping so as to apply pressure between boom and housing.
3. Apply glue to the smooth ends of two acryllic probe holders and insert one holder at each end of the cross boom.
4. Allow the housing/boom/probe holder subassembly to set over night.
5. Select a calibrated Thermosonde board, feed each probe cable through a probe holder, and connect a probe to each probe cable.
6. Gently slide each probe into its holder and visually inspect to insure adequate space between the electrical connections between probe and cable.
7. Insert the Thermosonde board in the housing/boom subassembly.
8. Secure the probe cables to the cross boom using equal amounts of duct tape on both sides of the boom (for balance).
9. With the Thermosonde board pressed in place, the probe cables secured (and any excess cable tucked carefully behind the board), position the styrofoam housing cover over the board and slide an aluminum outer cover over the styrofoam.
10. Scratch the aluminum cover with the ground wire from the Thermosonde board and firmly tape the ground wire to the aluminum.
11. Run a Ty-wrap through the back of a cardboard battery box.
12. Position a Radiosonde "back-to-back" with the Thermosonde assembly and loop the Ty-wrap around both units, positioning the battery box on the Thermosonde side. Tighten the Ty-wrap by hand in a plane just above the top of the Radiosonde battery receptacle.

13. Connect Thermosonde signal cable to mating cable from Radiosonde. (connect separate thermistor lead from T/S to R/S if applicable.)

14. After a final visual inspection, tighten and cut Ty-wrap with Ty-wrap gun. (Use standard rather than heavy-duty adjustment on gun.)

15. Neatly tape interconnecting cables to payload assembly.

16. Place calibration data and checklists in Radiosonde plastic bag, and tape bag to payload assembly.

APPENDIX 5

GROUND STATION FLIGHT CHECKLIST

DATE__________ SERIAL NO.__________ START TIME__________

1. INSTALL FORMATTED DATA DISK IN RIGHT HAND DRIVE 'B' __________

2. SET UP GROUND STATION IN PRE-FLIGHT MODE __________

3. COMPLETE MENU # 5 __________

4. THERMOSONDE OPERATING ON POWER SUPPLY __________

5. ASCII CODE O.K. __________

6. HYGRISTOR COUNTS __________

7. TEMPERATURE COUNTS __________

8. FLAP TEST __________

9. PROBE NOISE CHECK: probes covered. HIGH COUNTS_____
LOW COUNTS_____ __________

10. HEAT CHECK: MAX HIGH COUNTS = _______
MAX LOW COUNTS = _______ __________

11. DISCONNECT POWER TO RADIOSONDE/THERMOSONDE
LAY OUT STARTED AT TIME = HRS MIN (UT)
START INFLATION OF BALLOON, ACTIVATE BATTERIES. __________

11.1 RETURN POWER SUPPLY, LASH UP ANTENNA: TIME = _____ __________

12. COMPLETE MENU # 6, P=_____MB, T=_____C, U=_____%,WS=_____ __________

13. COMPLETE MENU # 7 __________

14. COMPLETE MENU # 8, ENTER THE THERMOSONDE CALIBRATIONS __________

15. NOISE VERIFICATION: LOW COUNTS=_______ __________

17. UNCAP PROBES: HIGH COUNTS = _______
LOW COUNTS = _______ __________

18. COLLECT GROUND DATA FOR TWO MINUTES (CLEAR AREA) __________

19. RECHECK SURFACE PRESSURE (CORRECT # 4 IF NECESSARY) __________

20. VERIFY 403 FREQ TUNED AND AFC IS ON, FREQ=______ __________

21. ORIENT ANTENNA IN DIRECTION OF PREDICATED FLIGHT
NOTE: keep watch in high counts, if drop less than 60, STOP __________

22. SYSTEM ARMED FOR FLIGHT __________

23. PERMISSION TO LAUNCH GIVEN AT TIME=_______ (UT) __________

DEPARTMENT OF THE AIR FORCE
AIR FORCE GEOPHYSICS LABORATORY (AFSC)
HANSCOM AIR FORCE BASE, MASSACHUSETTS 01731

REPLY TO ATTN OF: OPA/J. H. Brown/(617)861-3685 21 Jan 86

SUBJECT: Approval of Test/Demonstration Report - Contract No. F19628-85-C-0052

TO: R. Fries
Systems Integration Engineering, Inc.
Suite 12, The Liberties
35 Bedford St.
Lexington, MA 02173

1. The following report submitted in accordance with the terms of subject contract has been received by this office:

a. Report Number: 1

b. Date of Report: December 1985

c. Periods - From: One Time

d. Title of Report: First Article Test and Demonstration Report

e. Classification: Unclassified

2. This report is accepted. I concur with the security classification assigned.

REMARKS: Nothing in this letter constitutes a commitment of any type whereby it could form the basis of any future claims against the Government.

James H. Brown

JAMES H. BROWN
Contract Manager
Atmospheric Optics Branch
Optical Physics Division

cc: XOR
ESD/PKR
DAA
ACO/DCASMA

SIE 0052-0002-2

OTS PAYLOAD

FIRST ARTICLE

TEST/DEMONSTRATION REPORT

DECEMBER 1985

Prepared by

Systems Integration Engineering, Inc.

R. Fries, Principal Author

Contract No. F19628-85-C-0052

Item No. 0002AC

CDRL No.202

Prepared for
Optical Physics Division
Air Force Geophysics Laboratory

FOREWORD

This test report has been prepared in accordance with the instructions in Data Item Description DI-T-30736 as required by CDRL Item 202 of Contract F19628-85-0052.

CONTENTS

OTS PAYLOAD

FIRST ARTICLE TEST/DEMONSTRATION REPORT

1. TEST IDENTIFICATION

The test reported herein is the First Article Test/Demonstration required by Line Item 0002 of the contract.

2. PURPOSE OF TEST

The functional purpose of this test was qualification of the test article, an Optical Turbulence System (OTS) payload.

3. TEST OBJECTIVE

The test objective was to provide verification of acceptable performance of a representative OTS payload from the first lot of such payloads manufactured/assembled by the contractor.

4. TEST ARTICLE DESCRIPTION

The test article was an integrated, flight-ready OTS payload consisting of the following:

(1) Thermosonde circuit board

(1) Thermosonde housing assembly with cross arm

(2) Probe holders

(2) Tungsten fine wire probes with housings

(1) Thermosonde aluminum slip-on box

(2) Thermosonde batteries

(1) Digital "Locate" Radiosonde, modified for use with the Thermosonde.

(1) Complete set of finished cables including ferrite beads on probe cables

Additional descriptive information is provided in the Test Plan, Reference 1.

5. SUMMARY OF TEST RESULTS

The test article was successfully launched from the Reservoir Hill balloon launch area at Hanscom AFB on 10 December 1985. Launch conditions were sunny, with light winds and a ground level temperature of about 10 C.

Test data were acquired and reduced using the AFGL/OP ground station located in Building 1102F at AFGL. Although RF signal reception terminated earlier than expected, sufficient data were obtained to meet the test objective.

6. TEST FACILITY AND PROCEDURES

The test facility consisted of the helium fill and balloon launch facility on Reservoir Hill, and a ground station in Building 1102F at Hanscom AFB.

Procedures followed were those detailed in the test plan, Reference 1. The only deviation from those procedures was that flight batteries were used instead of a power supply (battery pack) during the early ground station flight checks. This minor deviation had no effect on the purpose or results of the test.

Pertinent procedural checklists and calibration data are provided in Appendix 1.

7. TEST SET-UP

Figure 1 is a sketch of the test set-up.

8. TEST DATA

The test data are the AFGL/OPA computer flight data and are provided in Appendix 2. Despite earlier than expected loss of signal (LOS), the flight data indicated that the purpose of the test was accomplished and the test objective met.

In particular, the flight data show that:

- o clean P, T, and U histories were obtained from launch to LOS;
- o minimum C_N values reached the noise curve periodically from launch to LOS;
- o relative maximum C_N observed during boundary layer inversion;
- o C_N data were reducible at least 95% of the time that the temperature data were nominal.

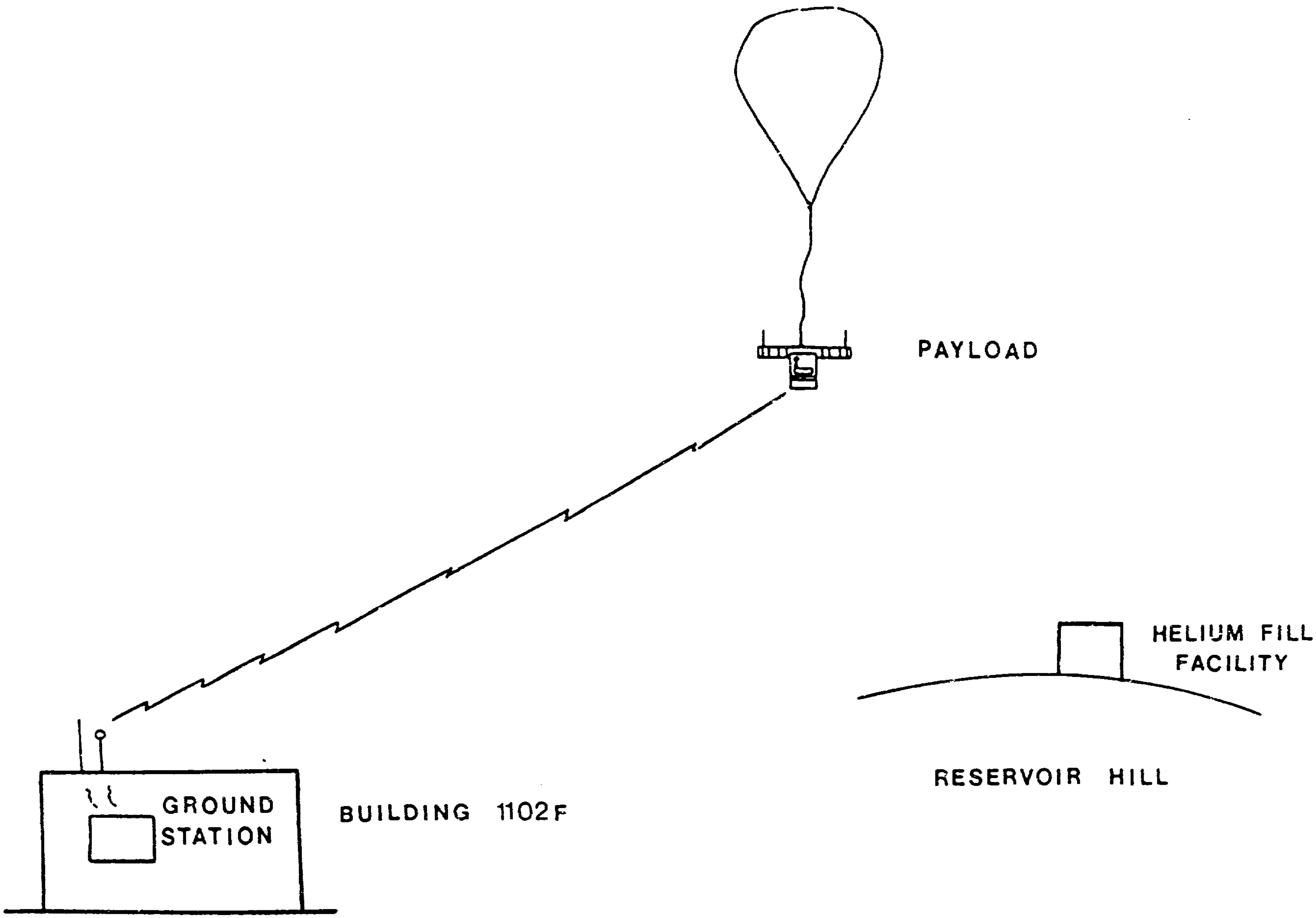


FIGURE 1 SKETCH OF TEST SET-UP

9. TEST CONDITIONS

Launch conditions were sunny, with light winds and a ground level temperature of about 10 C.

Launch time was 1655:43 UT (1155:43 EST) on 10 December 1985.

10. CERTIFICATION

It is hereby certified that the test results are authentic, accurate, current and in accordance with related specifications and test plans.

Richard E. Fries
Contractor PI

James H. Brown
Contract Monitor

APPENDIX A

Prelaunch Checklists and Calibration Data

RADIOSONDE CHECKLIST

MICROSONDE S/N 6852

MICROSONDE CHECKOUT	YES	NO
1. FLAP SWITCH	✓	
2. Bar Codes = VIZ sheet S/N	✓	
3. Enter pressure bar code, does calibration agree with VIZ	✓	
4. 399 Freq 405	✓	
5. Peak-to-Peak Amp 4 sm div	✓	
6. MET STRING RECEIVED	✓	

Date Completed 12/9/85

MICROSONDE MODIFICATION (performed per detailed SIE procedure)

1. OPEN AND INSPECT	✓
2. DRILL HOLES FOR CABLE	✓
3. SOLDER CABLE TO POINTS*	✓
4. INSTALL STRAIN RELIEF FOR CABLE	✓
5. CLOSE AND SEAL WITH RTV	✓

Date Completed 11/20/85

* Low and high gain signal leads were reversed. Connections were corrected on 12/10/85.

LABORATORY THERMOSONDE CALIBRATION

DATE 24 DEC 85

MICROSONDE S/N: M6 852
THERMOSONDE S/N: S/E 00
PROBE PAIR: 501

REF [illegible]
[illegible] 29.0C 26.97
Rp [illegible] 26.88

SIMULATED PROBES

Rp= 27.5

ACTUAL PROBES

Rp AVG= [illegible] 26.92

	LO GAIN	HI GAIN	
R#	RMS volts		RMS volts
R 0	0.039	R 0	0.198
R 2	0.083	R 1	0.266
R 3/2	0.236	R 2	0.426
R 4/2	0.396	R 3	0.788
R 7	0.782	R 3/2	1.183
R 8	1.180	R 4	1.583
R 9	1.578	R 4/2	1.979
R 10	1.943	R 5	2.378
R 11	2.349	R 5/2	2.772
R 12	2.736	R 6	3.121
R 12/4/2	3.129	R 7	3.914
R 12/7	3.509	-	
R 12/8	3.900	-	

CALIBRATION

flight name = test

R0 =

VREF =

electronics thermistor R =

thermistor R = 13974

hygristor R = 10761

BAROSWITCH TABLE

0	10646	10535	10424	10314	10203	10092	9982	9876	9770
9664	9559	9454	9348	9244	9140	9036	8933	8830	8728
8628	8528	8428	8330	8232	8134	8035	7936	7836	7740
7644	7548	7453	7358	7262	7167	7072	6978	6887	6796
6706	6614	6522	6430	6341	6252	6164	6077	5990	5902
5816	5730	5644	5561	5478	5394	5313	5232	5150	5070
4990	4910	4831	4752	4672	4595	4518	4442	4367	4292
4218	4145	4072	4000	3930	3860	3790	3722	3654	3586
3519	3452	3386	3321	3256	3190	3127	3064	3002	2942
2882	2822	2763	2704	2646	2589	2532	2474	2419	2364
2308	2256	2204	2152	2101	2050	2000	1951	1902	1852
1805	1758	1710	1666	1622	1578	1534	1490	1446	1405
1364	1324	1285	1246	1206	1168	1130	1092	1056	1020
984	950	916	882	849	816	784	753	722	690
659	628	598	569	540	510	482	454	426	399
372	346	319	292	266	239	212	186	159	132
106	81	56	30	5	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

BAROSWITCH PRESSURE CALIBRATION CHART

DATE ______________ RELEASE TIME, G.M.T. ______________ SOUNDING NO. ______________

STATION ______________ COMPUTED NO. DETENT CLICKS ______________

BAROSWITCH SERIAL NO. 315 - 1478 * DETENT CLICK VALUE .50

	1 1064.6	2 1053.6	3 1042.4	4 1031.4	5 1020.6	6 1009.4	7 998.2	8 987.8	9 977.2
10 966.4	11 955.6	12 945.0	13 934.8	14 924.2	15 914.0	16 903.6	17 893.4	18 883.0	19 872.8
20 862.8	21 852.6	22 842.8	23 832.8	24 822.8	25 813.4	26 803.2	27 793.6	28 783.6	29 774.0
30 764.4	31 754.8	32 745.0	33 735.6	34 726.2	35 716.8	36 707.4	37 697.8	38 688.6	39 679.6
40 670.6	41 661.4	42 652.0	43 643.0	44 634.0	45 625.2	46 616.4	47 607.6	48 598.8	49 590.2
50 581.6	51 573.0	52 564.4	53 556.0	54 547.8	55 539.4	56 531.2	57 522.8	58 515.0	59 506.8
60 499.0	61 491.0	62 483.0	63 475.2	64 467.2	65 460.0	66 452.2	67 [illegible]	68 436.8	69 429.[illegible]
70 421.8	71 414.6	72 407.4	73 400.0	74 393.0	75 386.0	76 379.0	77 372.2	78 365.2	79 358.6
80 351.8	81 345.0	82 338.6	83 331.8	84 325.6	85 319.0	86 312.8	87 306.4	88 300.2	89 294.0
90 288.2	91 282.2	92 276.0	93 270.2	94 264.6	95 258.8	96 253.0	97 247.4	98 241.8	99 236.2
100 230.8	101 225.4	102 220.4	103 215.2	104 210.0	105 204.8	106 200.0	107 195.0	108 190.0	109 185.2
110 180.4	111 175.8	112 171.0	113 166.8	114 162.2	115 157.8	116 153.2	117 148.8	118 144.6	119 140.4
120 136.4	121 132.4	122 128.4	123 124.4	124 120.6	125 116.6	126 112.8	127 109.2	128 105.6	129 102.0
130 98.4	131 94.8	132 91.4	133 88.2	134 84.8	135 81.4	136 78.4	137 75.2	138 72.0	139 69.0
140 65.6	141 62.8	142 59.8	143 56.8	144 54.0	145 51.0	146 48.2	147 45.6	148 42.6	149 40.0
150 37.2	151 34.6	152 32.0	153 29.2	154 26.6	155 24.0	156 21.2	157 18.6	158 16.0	159 13.4
160 10.6	161 8.2	162 5.4	163 3.0	164 .0	165 .0	166 .0	167 .0	168 .0	169 .0
170 .0	171 .0	172 .0	173 .0	174 .0	175 .0	176 .0	177 .0	178 .0	179 .0

CONTACT VALUES FOR MANDATORY LEVELS

1000	6.83	300	88.03	70	138.66	7	161.42
850	21.26	250	96.53	50	145.35	5	162.16
700	36.77	200	106.00	30	152.71	3	163.00
500	59.87	150	116.72	20	156.46	2	163.41
400	73.00	100	129.55	10	160.25	1	163.83

VIZ MANUFACTURING CO.
335 E. PRICE ST., PHILA., PA. 19144 215-844-2626

VIZ FORM NO. 1292-168
AAI 3/84

0000 0000 0000 0000 44 63986 31055 32

CALIBRATION DATA

THERMISTOR

13974

HUMIDITY ELEMENT

10761

BAROSWITCH 315-1478

323 332 0 7 1 2 2 4 3 -2 [illegible] 1 1 6

-2 5 2 2 4 3 2 1 4 3 3 4 3 2 2 4

4 2 2 3 5 2 2 3 5 0 5 2 2 3 3 2

2 1 2 2 2 0 0 0 2 0 0 0 0 0 0 0

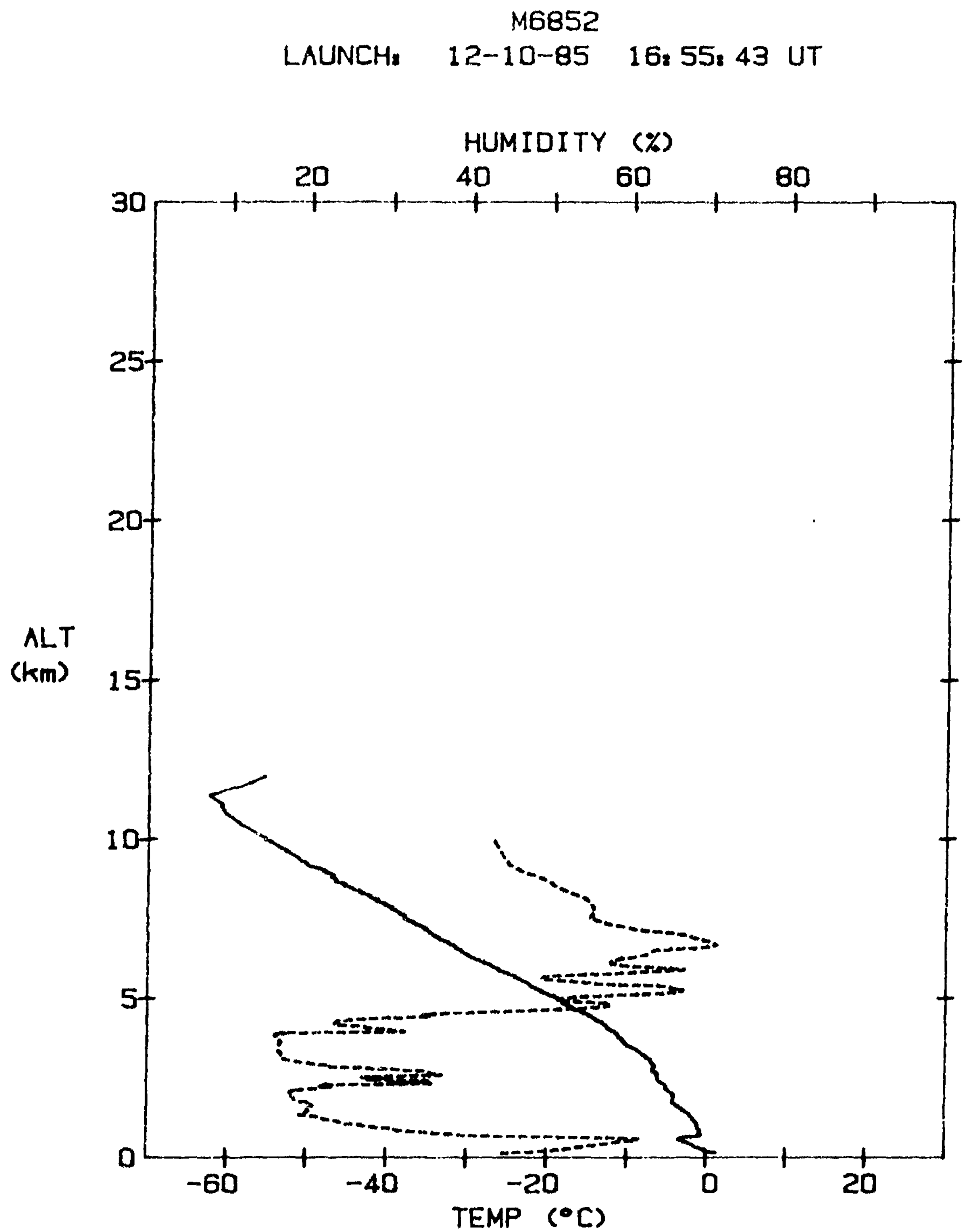
GROUND STATION FLIGHT CHECKLIST

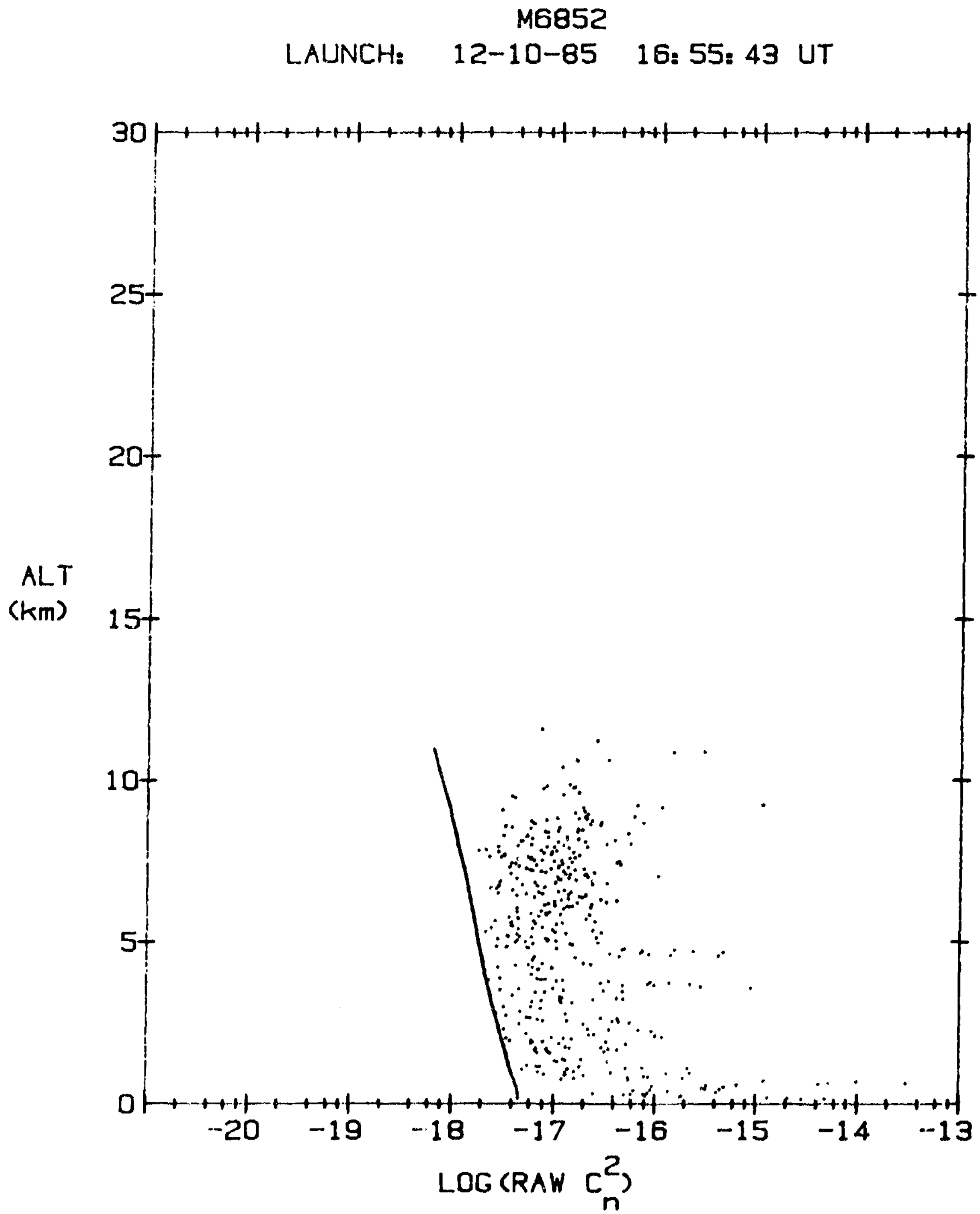
DATE 10 DEC 85 SERIAL NO. M6852 START TIME 0930 LOCAL

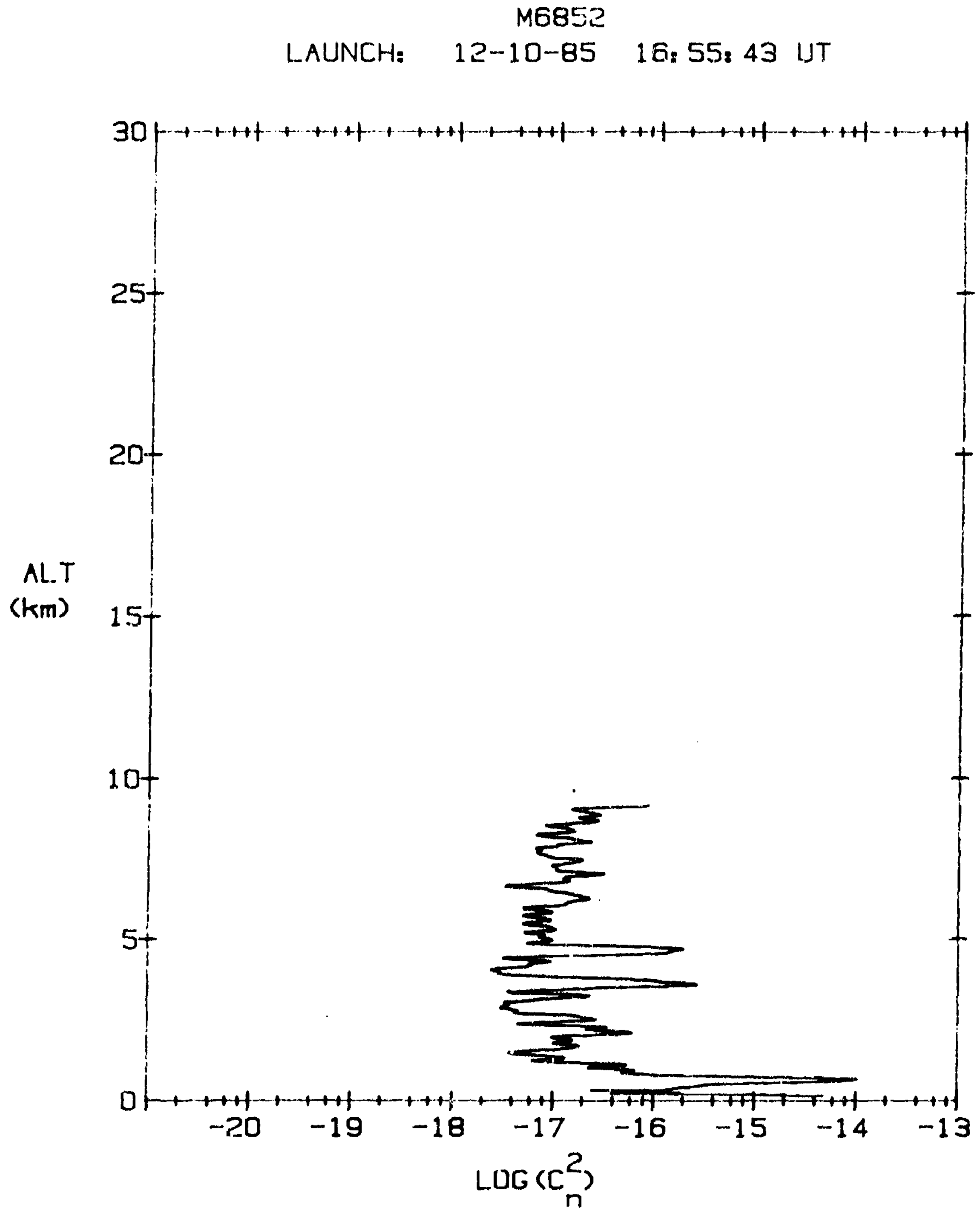
1. INSTALL FORMATTED DATA DISK IN RIGHT HAND DRIVE 'B'	✓
2. SET UP GROUND STATION IN PRE-FLIGHT MODE	✓
3. COMPLETE MENU # 5	✓
4. THERMOSONDE OPERATING ON POWER SUPPLY	✓
5. ASCII CODE O.K.	✓
6. HYGRISTOR COUNTS	570
7. TEMPERATURE COUNTS	720
8. FLAP TEST	✓
9. PROBE NOISE CHECK: probes covered. HIGH COUNTS 102 LOW COUNTS 28	✓
10. HEAT CHECK: MAX HIGH COUNTS = @ 338 MAX LOW COUNTS = 998	✓
11. DISCONNECT POWER TO RADIOSONDE/THERMOSONDE LAY OUT STARTED AT TIME = 9 HRS 40 MIN ~~(UT)~~ LOCAL START INFLATION OF BALLOON, ACTIVATE BATTERIES.	✓
11.1 RETURN POWER SUPPLY, LASH UP ANTENNA: TIME = N/A	(batteries used)
12. COMPLETE MENU # 6, P=1022.5MB, T= 10 C, U= 31 %,WS= calm / 2.5 / 10	✓
13. COMPLETE MENU # 7	✓
14. COMPLETE MENU # 8, ENTER THE THERMOSONDE CALIBRATIONS	✓
15. NOISE VERIFICATION: LOW COUNTS= 27	✓
17. UNCAP PROBES: HIGH COUNTS = @ 383 LOW COUNTS = @ 383	✓
18. COLLECT GROUND DATA FOR TWO MINUTES (CLEAR AREA)	✓
19. RECHECK SURFACE PRESSURE (CORRECT # 4 IF NECESSARY)	✓
20. VERIFY 403 FREQ TUNED AND AFC IS ON, FREQ= 401	✓
21. ORIENT ANTENNA IN DIRECTION OF PREDICATED FLIGHT (south) NOTE: keep watch in high counts, if drop less than 60, STOP	✓
22. SYSTEM ARMED FOR FLIGHT	✓
23. PERMISSION TO LAUNCH GIVEN AT TIME= 1156 ~~(UT)~~ LOCAL	✓

APPENDIX B

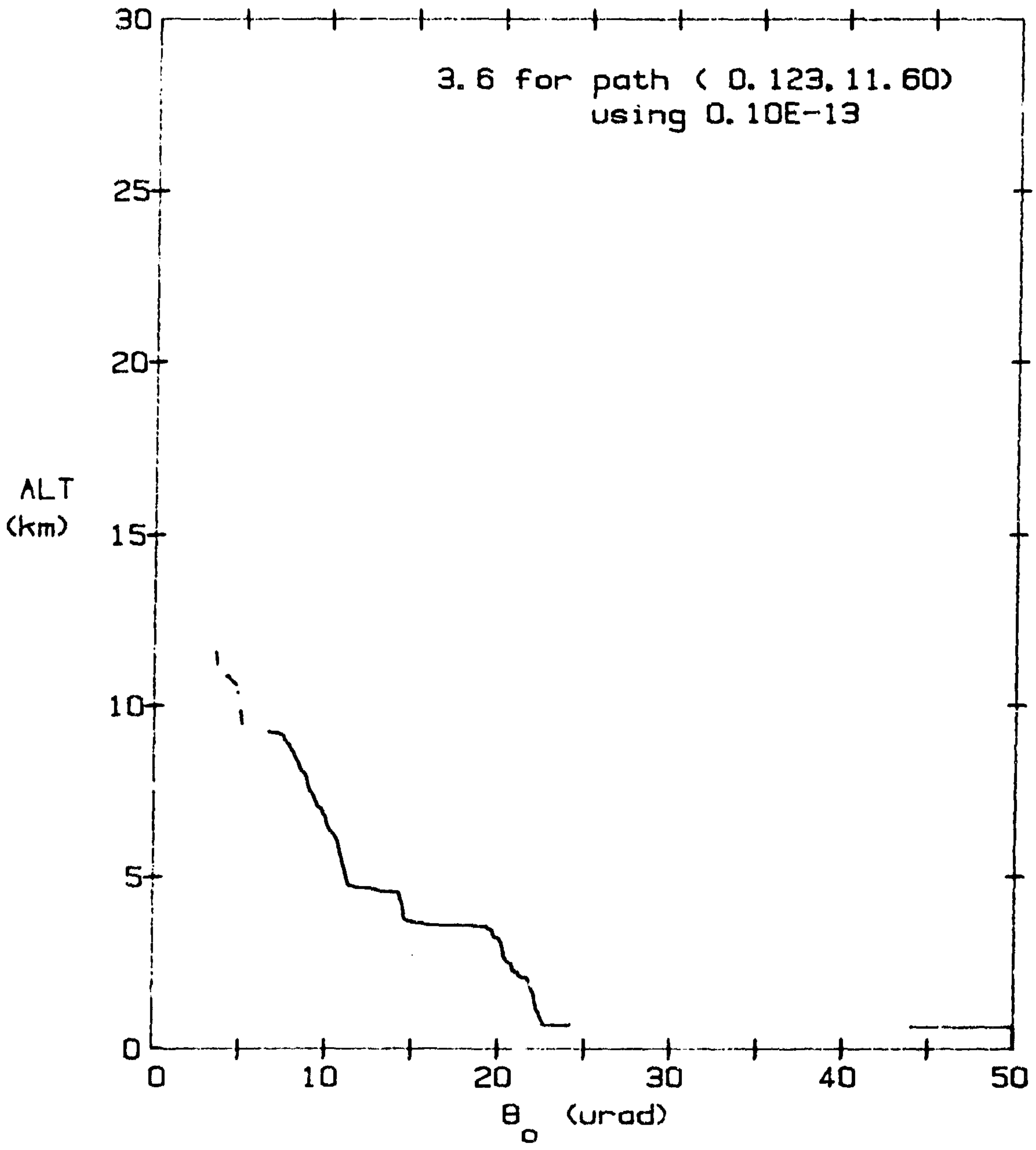
Flight Test Data

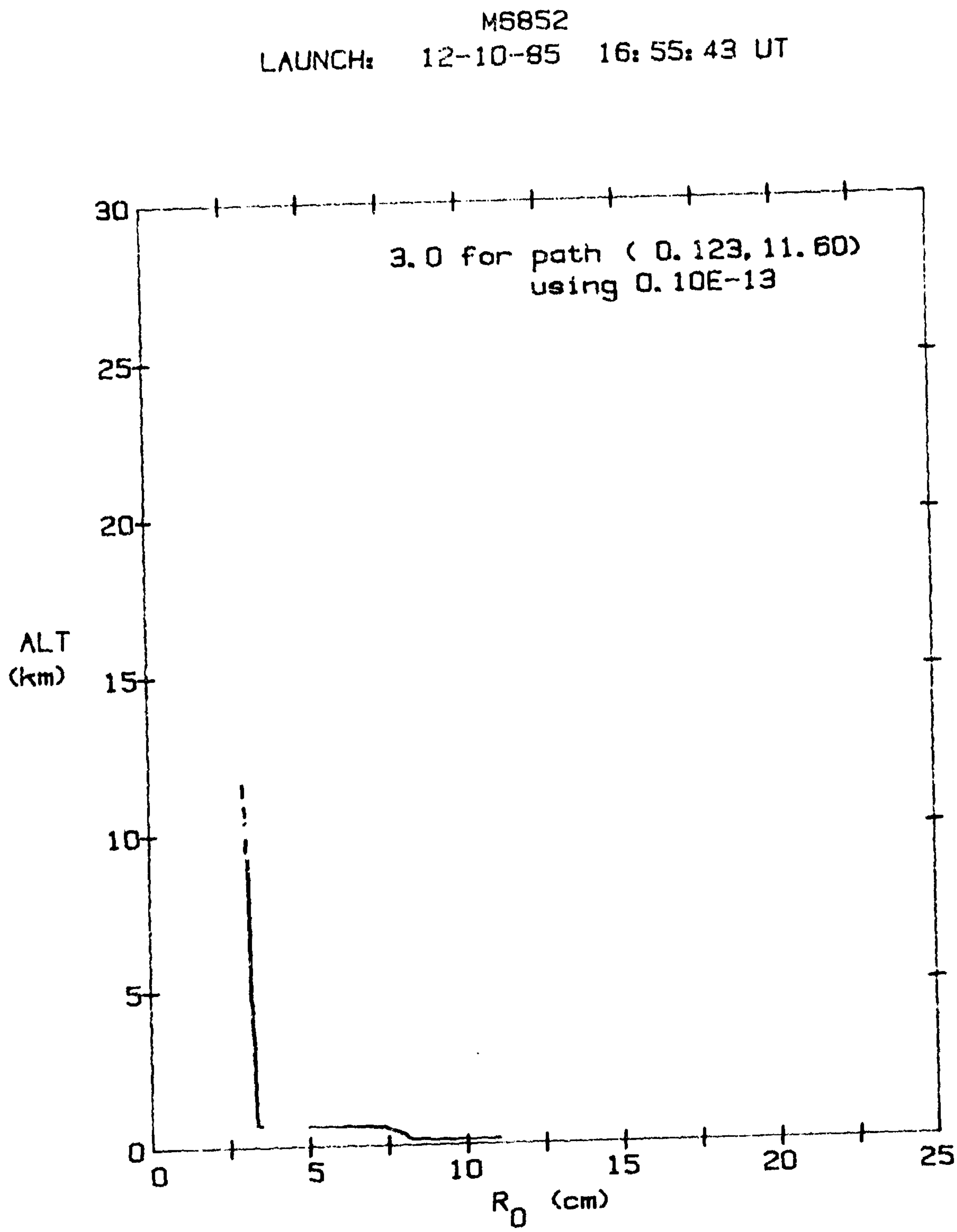

M6852
LAUNCH: 12-10-85 16:55:43 UT
HUMIDITY (%)
20
40
60
80
30
25
20
ALT
(km)
15
10
5
0
-60
-40
-20
0
20
TEMP (°C)


M6852
LAUNCH: 12-10-85 16: 55: 43 UT
30
25
20
ALT
(km)
15
10
5
0
-20
-19
-18
-17
-16
-15
-14
-13
LOG (RAW C_n^2)

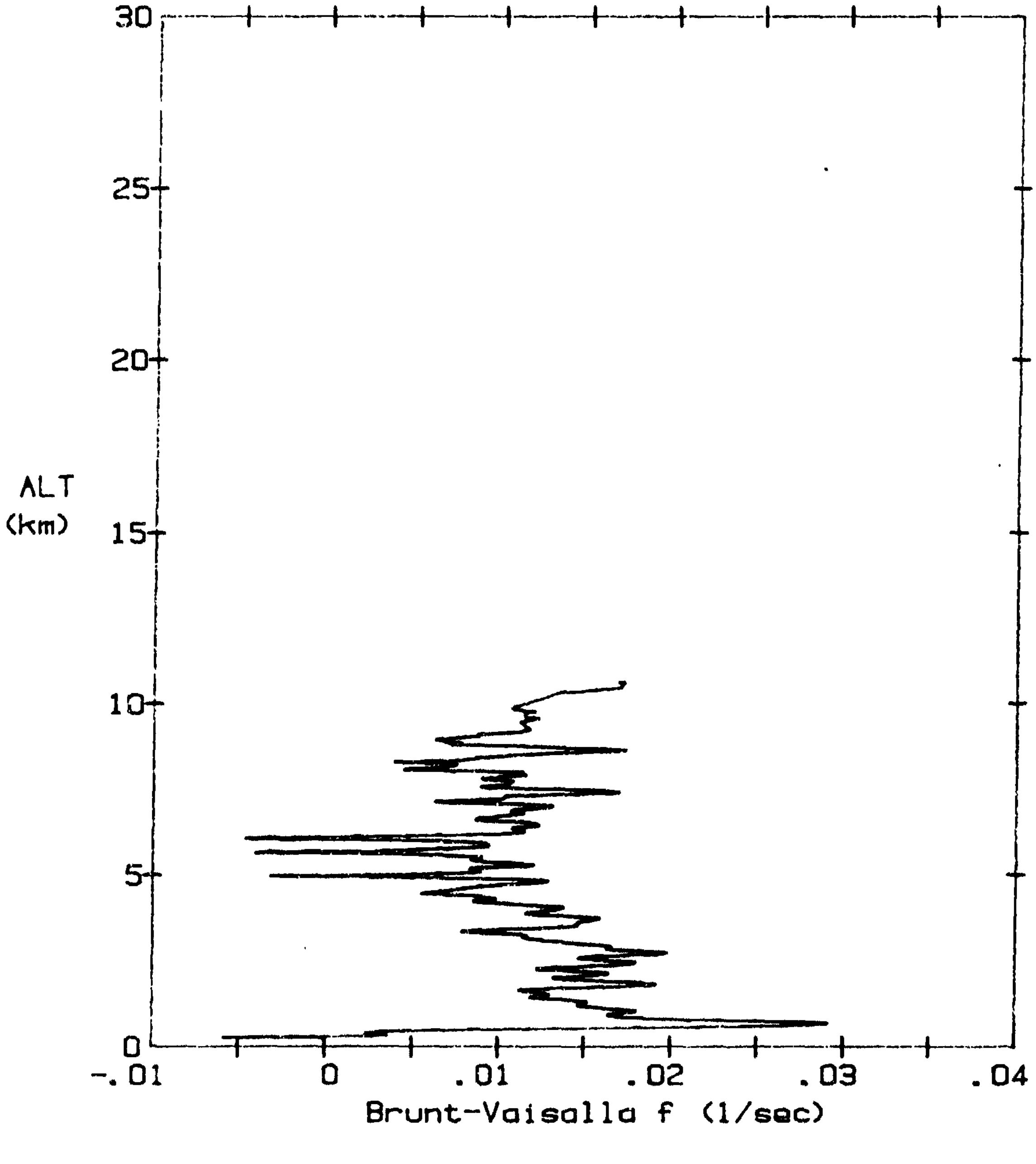

M6852
LAUNCH: 12-10-85 16:55:43 UT
ALT
(km)
30
25
20
15
10
5
0
-20
-19
-18
-17
-16
-15
-14
-13
LOG (C_n^2)

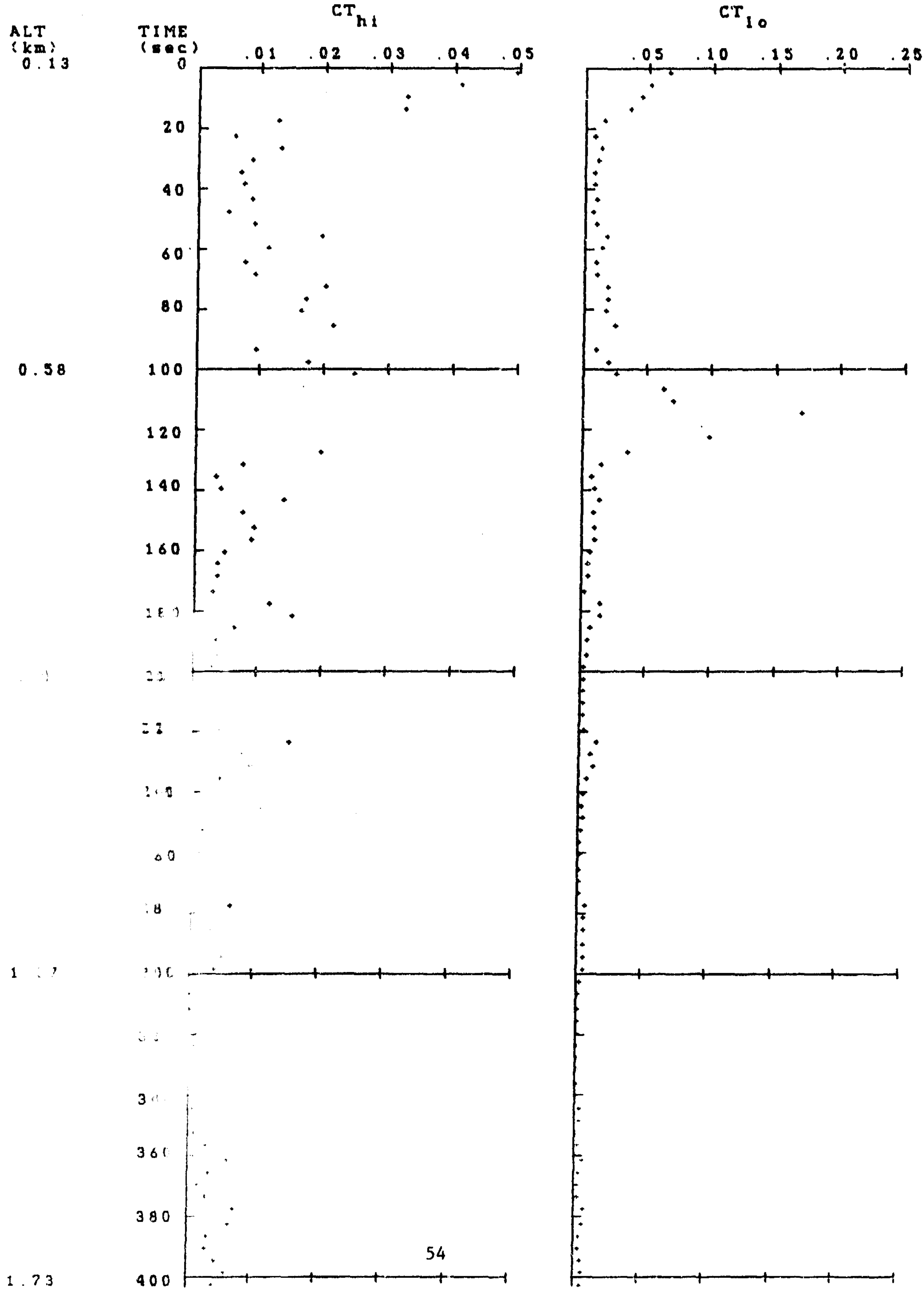
M6852
LAUNCH: 12-10-85 16:55:43 UT

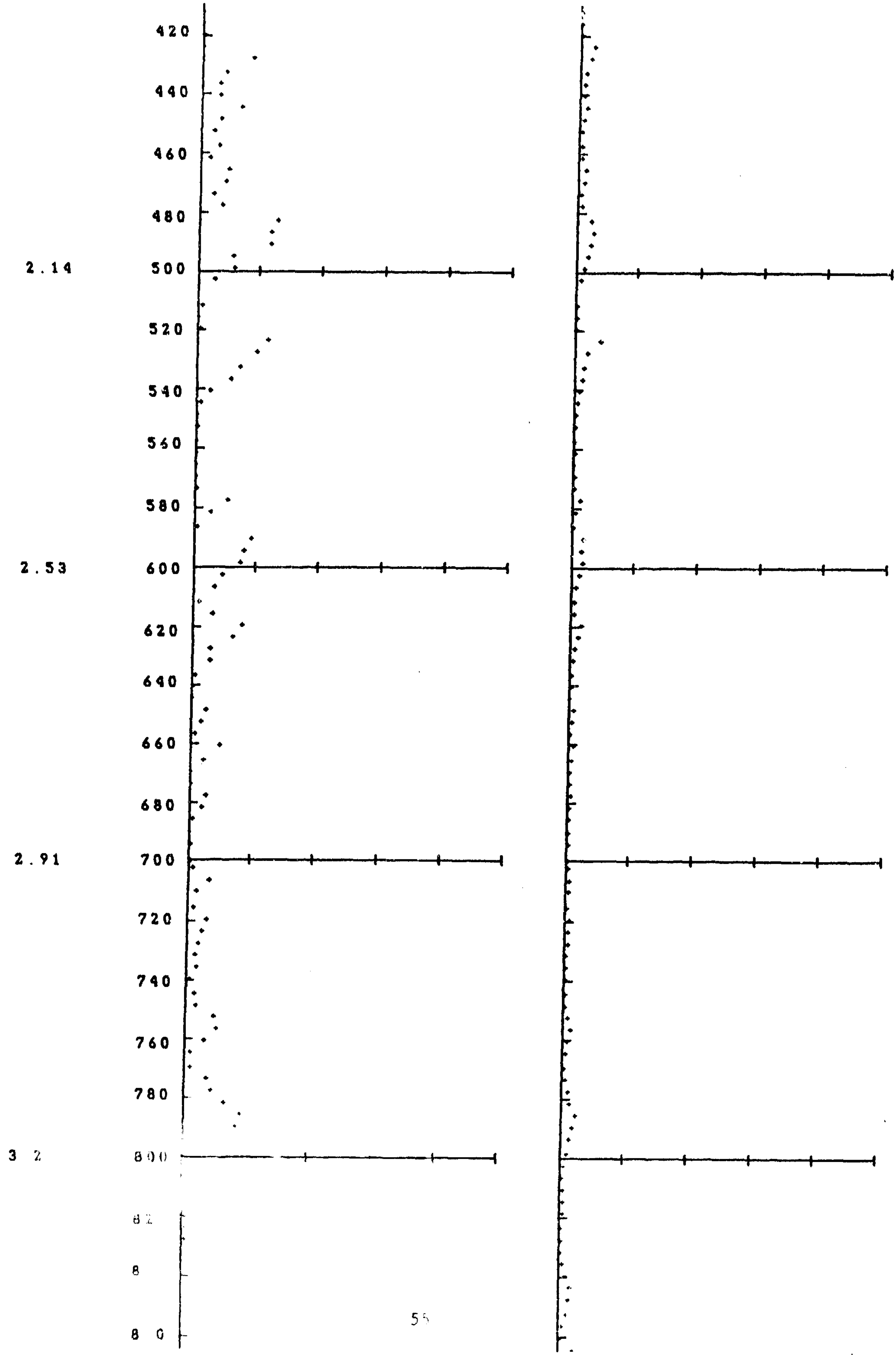


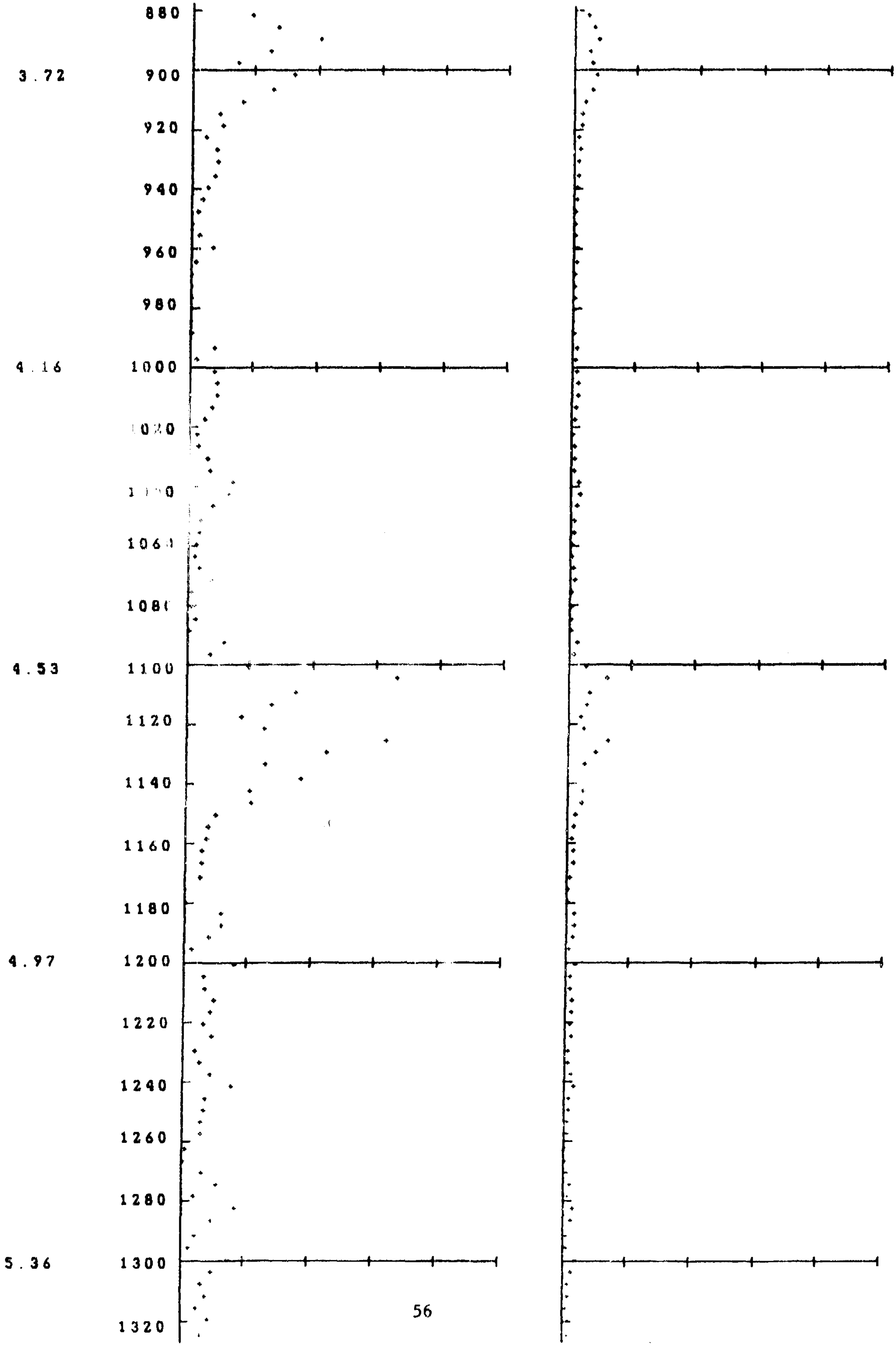

M6852
LAUNCH: 12-10-85 16:55:43 UT
3.0 for path (0.123, 11.60)
using 0.10E-13
ALT
(km)
30
25
20
15
10
5
0
0
5
10
15
20
25
R_0 (cm)

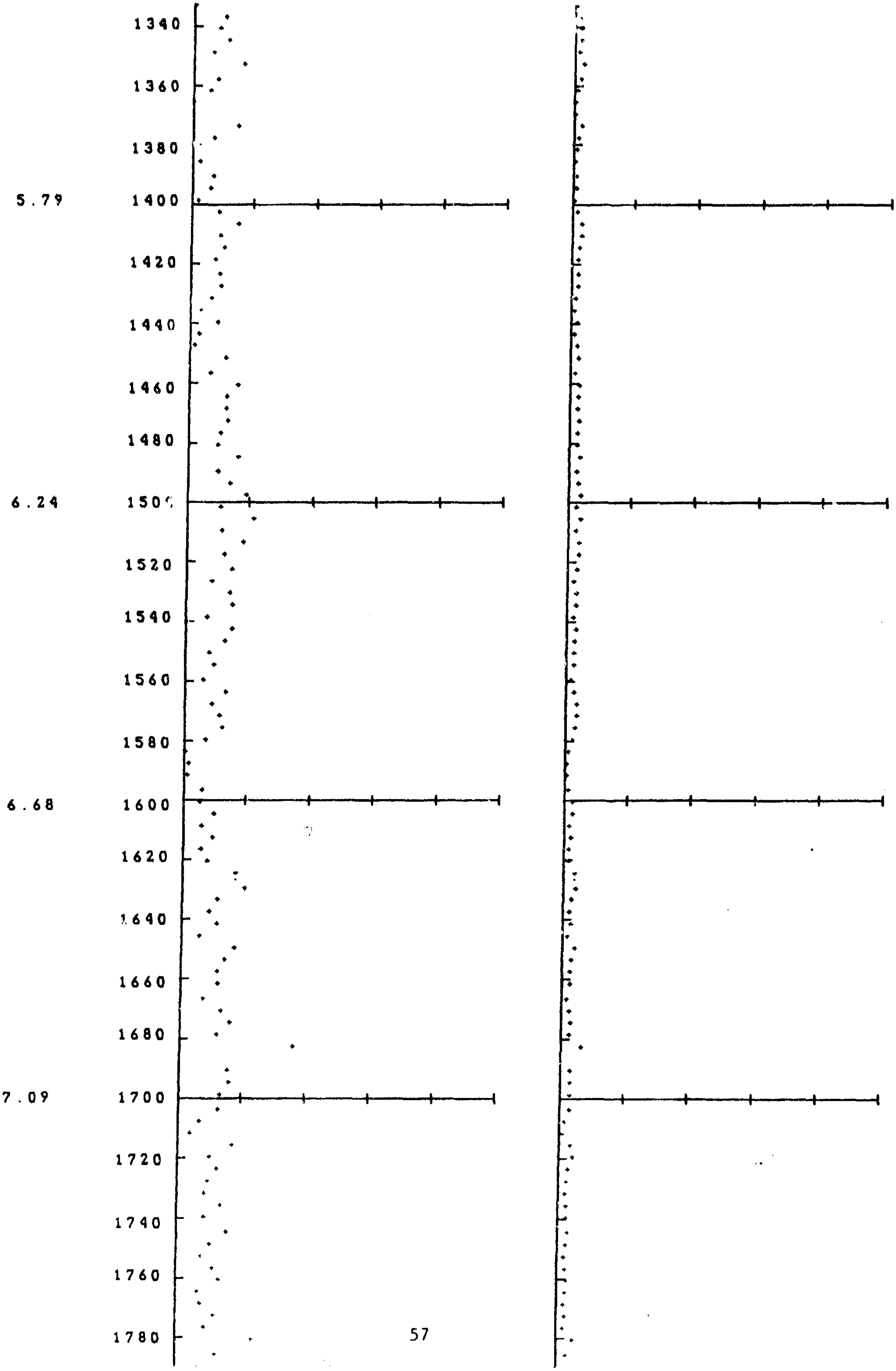
M6852
LAUNCH: 12-10-85 16:55:43 UT

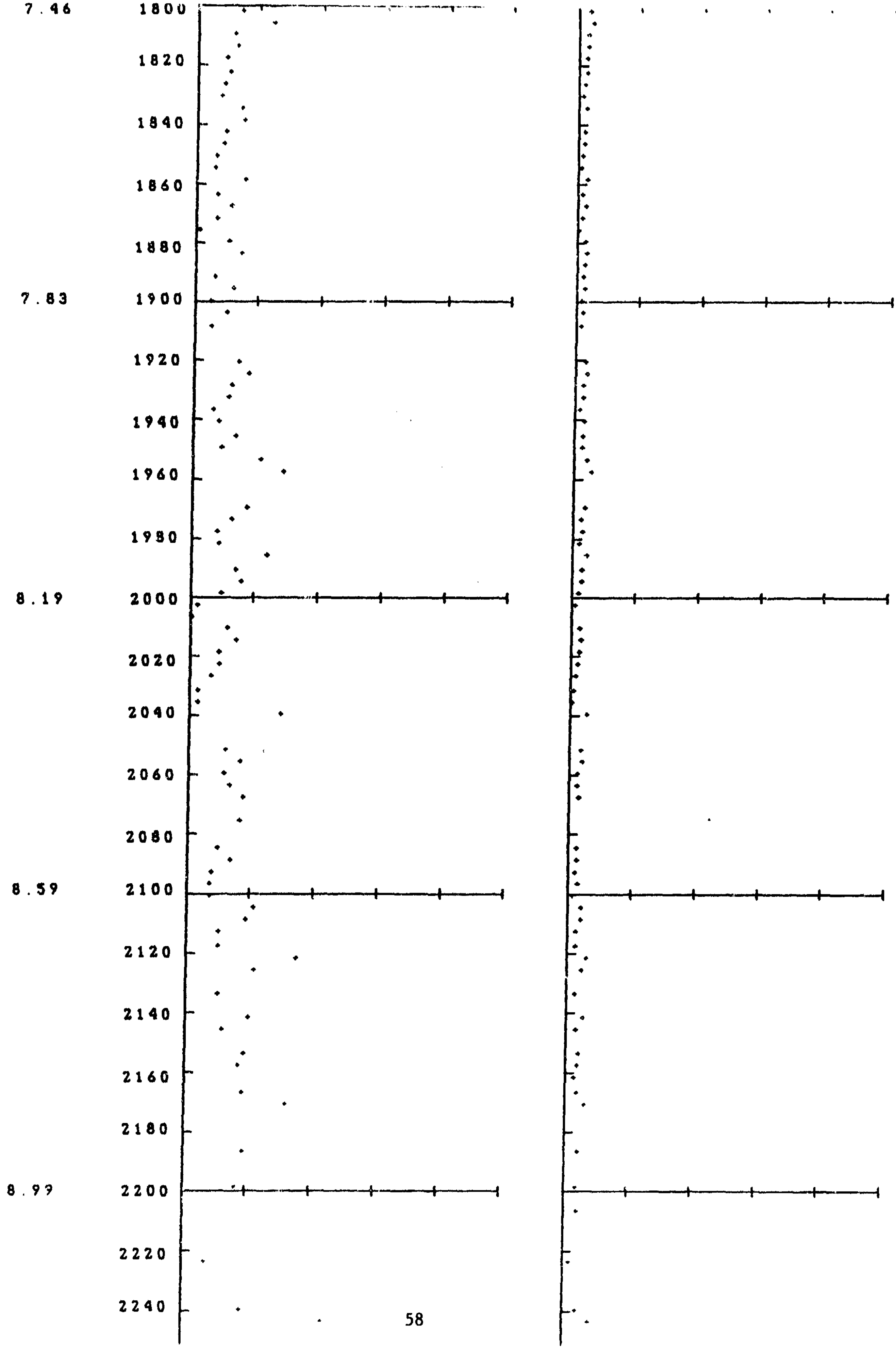


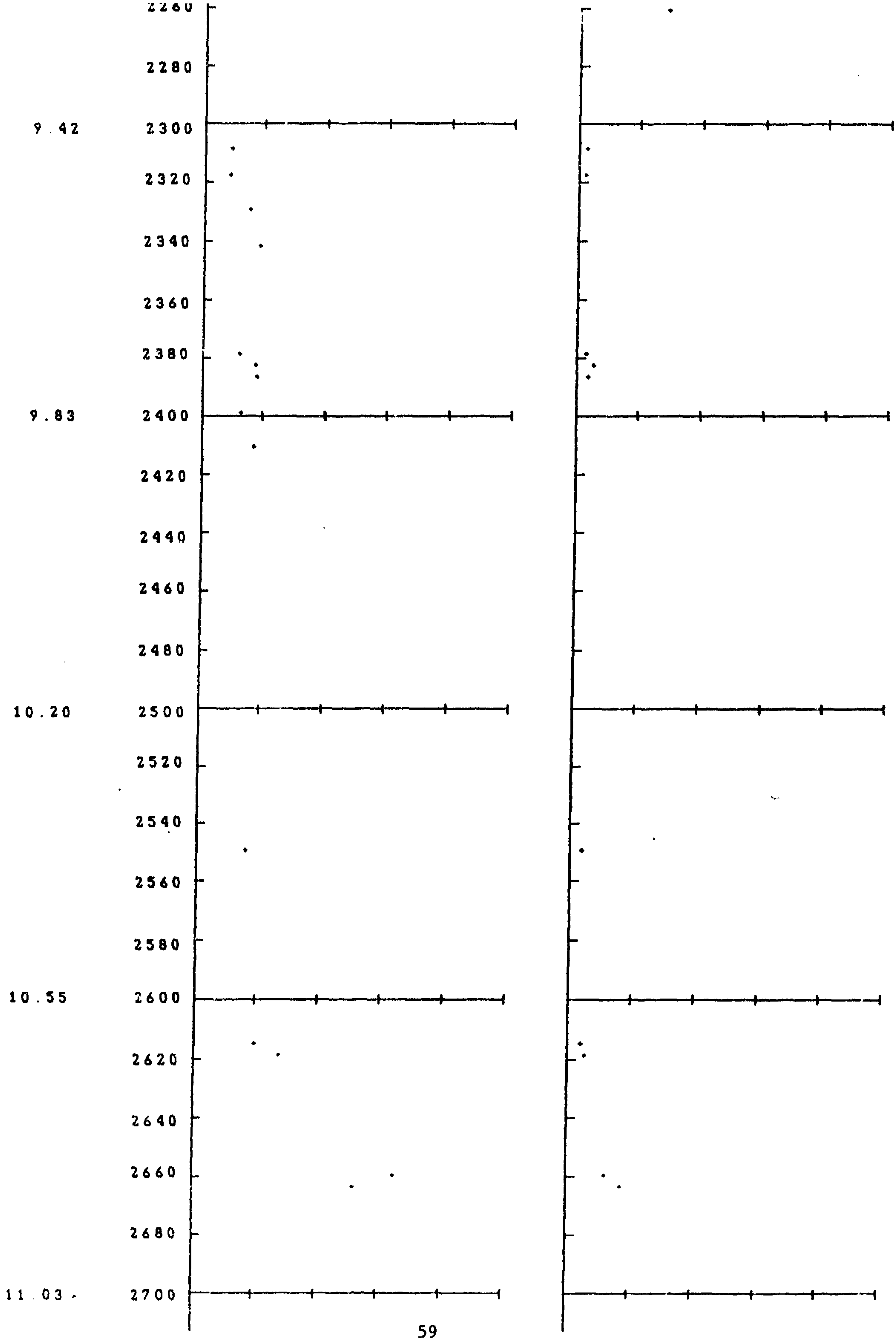

CT hi
CT lo
ALT (km)
TIME (sec)
.01 .02 .03 .04 .05
.05 .10 .15 .20 .25
0.13
0.58
1.73
0
20
40
60
80
100
120
140
160
380
400


420
440
460
480
2.14
500
520
540
560
580
2.53
600
620
640
660
680
2.91
700
720
740
760
780
800

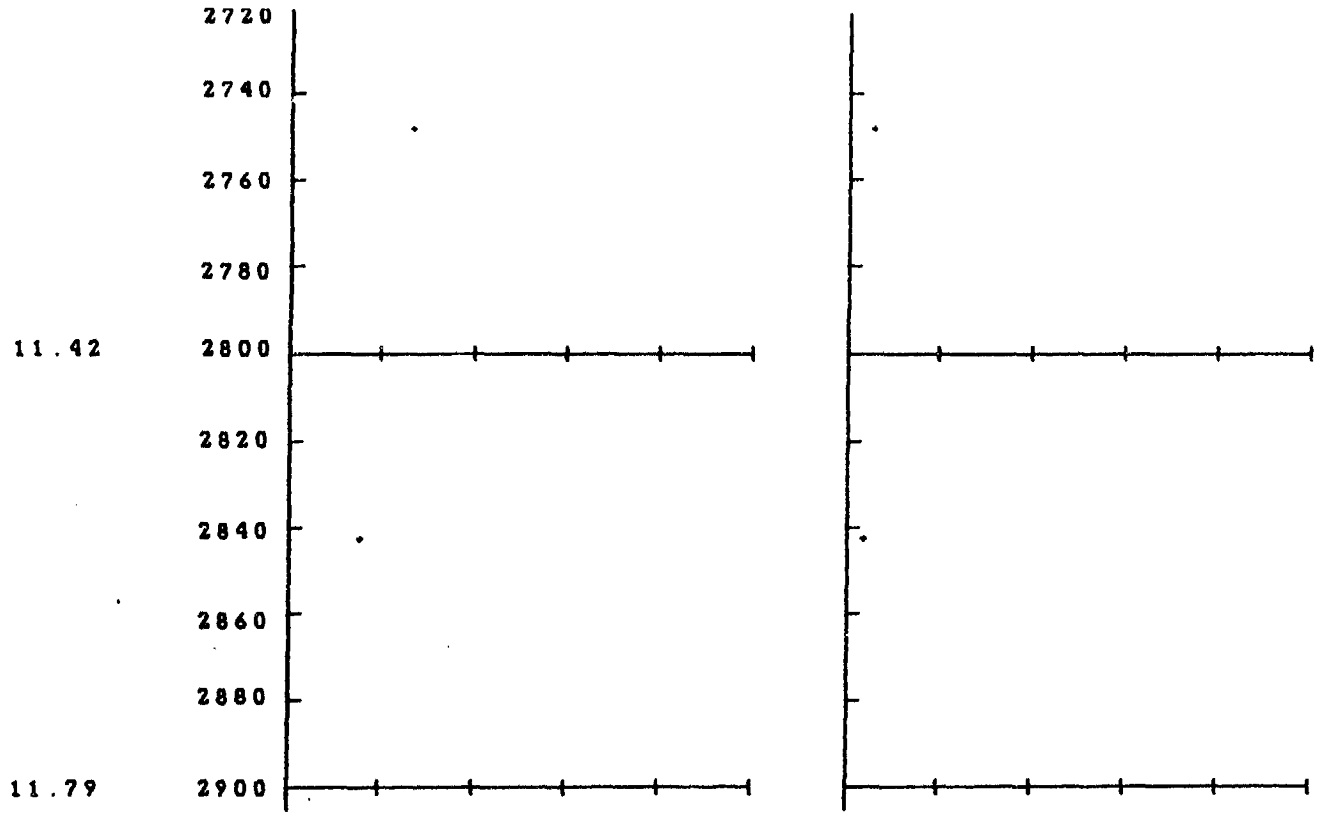

3.72
4.16
4.53
4.97
5.36
880
900
920
940
960
980
1000
1080
1100
1120
1140
1160
1180
1200
1220
1240
1260
1280
1300
1320


1340
1360
1380
5.79
1400
1420
1440
1460
1480
6.24
1520
1540
1560
1580
6.68
1600
1620
1640
1660
1680
7.09
1700
1720
1740
1760
1780


7.46
7.83
8.19
8.59
8.99
1800
1820
1840
1860
1880
1900
1920
1940
1960
1980
2000
2020
2040
2060
2080
2100
2120
2140
2160
2180
2200
2220
2240



2260
2280
9.42
2300
2320
2340
2360
2380
9.83
2400
2420
2440
2460
2480
10.20
2500
2520
2540
2560
2580
10.55
2600
2620
2640
2660
2680
11.03
2700


2720
2740
2760
2780
11.42
2800
2820
2840
2860
2880
11.79
2900

PRESSURE SENSOR BOARD

PREPARED BY:

SYSTEMS INTEGRATION ENGINEERING

PREPARED FOR:

AFGL/OPA

CONTRACT: F19628-85-C-0052

TABLE OF CONTENTS

FORWARD

As part of Clin 006 of contract F19628-85-C-0052, Systems Integration Engineering, Inc. was requested to design and fabricate a Pressure Sensing Board to accurately measure the pressure profile of the typical thermosonde measuring environment. This document describes the Pressure Sensing Board (PSB) design and includes an electrical schematic with its associated parts list. Testing has been completed to demonstrate the linearity of the PSB electrical output with pressure. Accuracy of the device is estimated to be within ± 0.6%.

1.0 DESCRIPTION

The Pressure Sensing Board was designed to provide more accurate altimeter measurements than those obtained from the Radiosonde baroswitch mechanism.

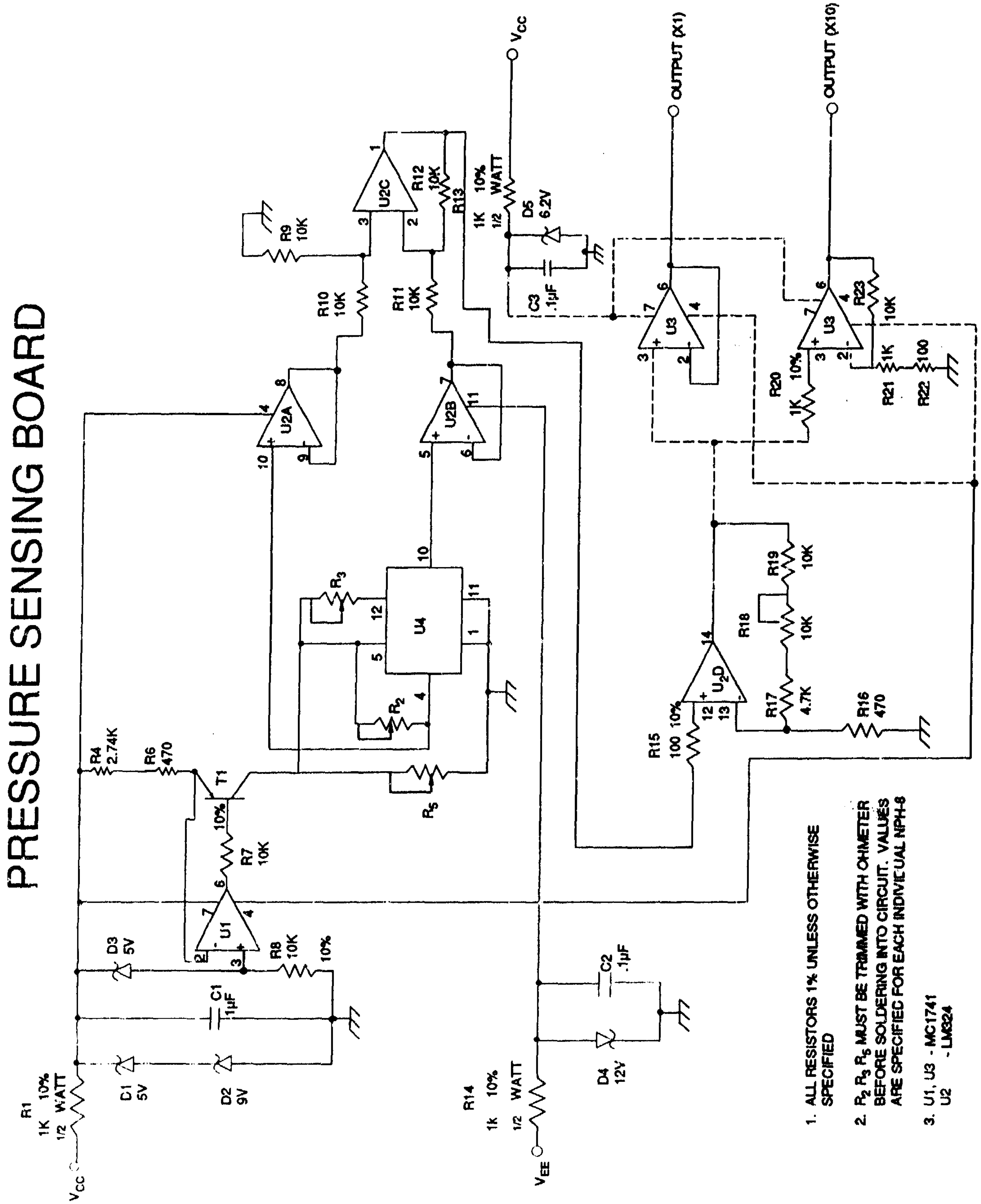
One board consists of an accurate current source, NPH-8-100A transducer, and signal conditioning in the output. The circuit is constructed on a 3.38 X 2.88 inch PC board. One flight package will consist of two boards, one with a nominal gain of X1, the other with a X10 gain to provide for greater sensitivity at higher altitudes. The resulting package, with styrofoam enclosure, will have dimensions on the order of 7 X 6 X 4 inches. The power interface between the flight package and battery box is provided by two molex connectors identical to these used by the Thermosonde. Also, the Pressure Sensing Boards will use the same molex connectors for signal outputs to the Radiosonde.

The PSB current source will be set to a value of between 1.5 and 1.8 mA and will remain constant to within 0.5% for loads ranging from 0 to 8 kilohms.

The transducer is configured as a piezoresistive strain gauge within a wheatstone bridge. The maximum nonlinearity of it's voltage output is rated at 0.1%. The maximum thermal error, with resistors R2, R3, and R5 correctly set, is 0.5%.

The output circuitry converts the signal from the transducer to a single-ended output and amplifies it to 3.9 volts at one atmosphere for the X1 gain board. The x10 gain board output is useful only at lower pressures, because the signal output is limited to 5 volts. Each board manufactured has its own calibration curve which provides accurate offset and pressure vs voltage curves.

2.0 ELECTRICAL SCHEMATIC



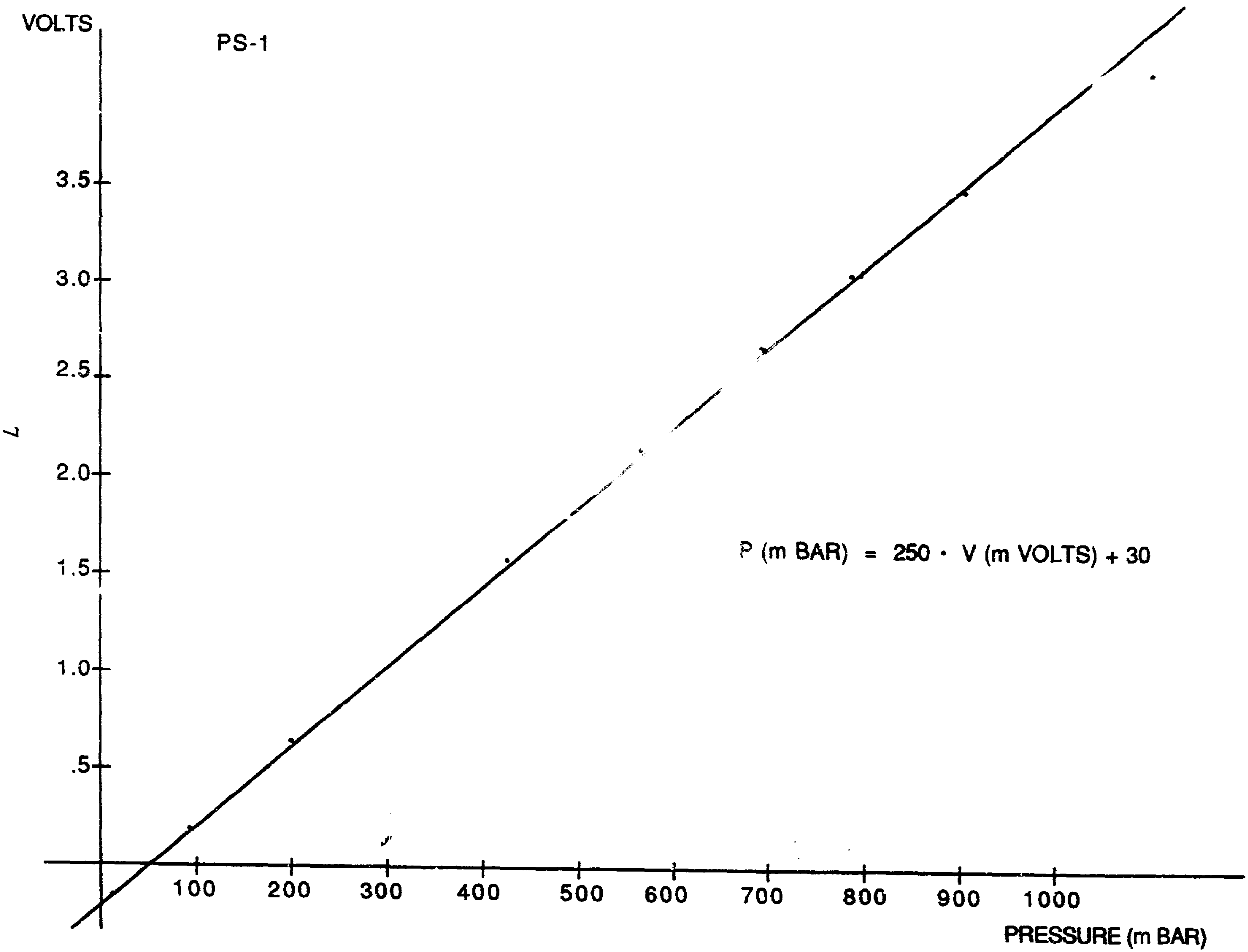
3.0 PARTS LIST

ITEM #	QTY	PART NUMBER	DESCRIPTION	REFERENCE
1	6	RN55C	10 K 1%	R9, R10, R11, R12, R19, R23
2	2	RN55C	470 OHM 1%	R6, R16
3	1	RN55C	2.74 K 1%	R4
4	1	RN55C	1 K 1%	R21
5	1	RN55C	4.7 K 1%	R17
6	1	RN55C	100 OHM 1%	R22
7	2	RCR07G	10 K 10%	R7, R8
8	3	RCR07G	1K 10% 1/2 Watt	R1, R13, R14
9	1	RCR07G	1 K 10%	R20
10	1	RCR07G	100 OHM 10%	R15
11	1	3099P	100 OHM 20 turn Pot	R3
12	1	3099P	10 K 20 turn Pot	R18
13	1	3099P	50 K 20 turn Pot	R5
14	1	3099P	500 K 20 turn Pot	R2
15	3	CK05	.1 µF 20%	C1, C2, C3
16	2	IN5231	5 V Zener	D1, D3
17	1	IN5234	6.2 V Zener	D5
18	1	IN5239	9 V Zener	D2
19	1	IN5242	12 V Zener	D4
20	1	NTE-273	PNP Darlington	T1
21	2	MC1741	OP Amp	U1, U3
22	1	LM324	Quad Op Amp	U2
23	1	NPH-8-100A	Transducer	U4

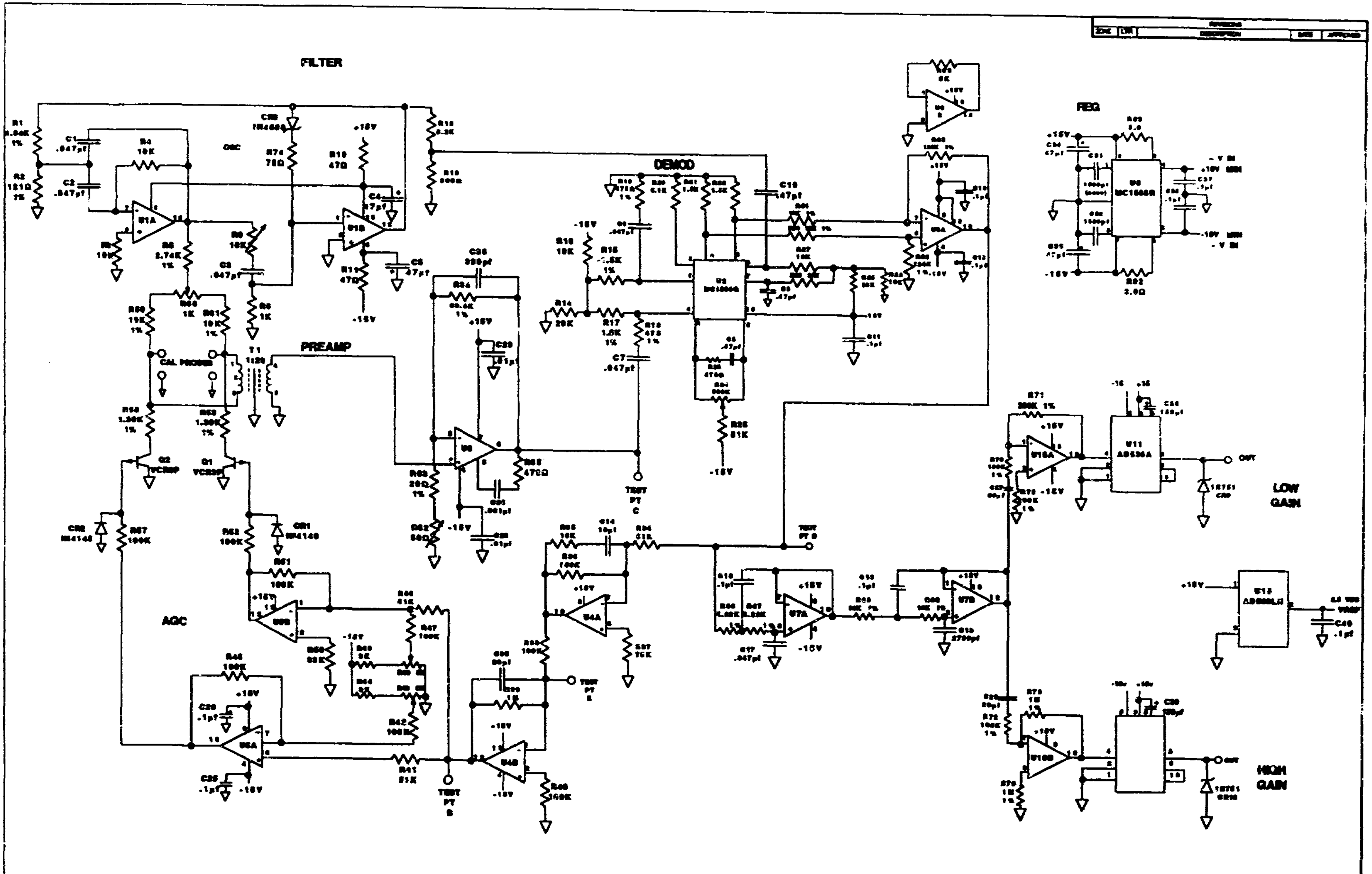
4.0 Testing and Calibration

The boards are tested in the pressure chamber located at AFGL/LC's Environmental Testing and Verification facility. Data is obtained in the range from 8 mbar to 1 atmosphere and plotted on a calibration curve. From this curve the precise offset and pressure-in versus voltage-out scale factor is determined. These parameters can then be used for ground equipment processing of the inflight data.

A sample calibration curve is included in this document.


VOLTS
PS-1
3.5
3.0
2.5
2.0
1.5
1.0
.5
100
200
300
400
500
600
700
800
900
1000
PRESSURE (m BAR)
P (m BAR) = 250 · V (m VOLTS) + 30

7



NOTES:

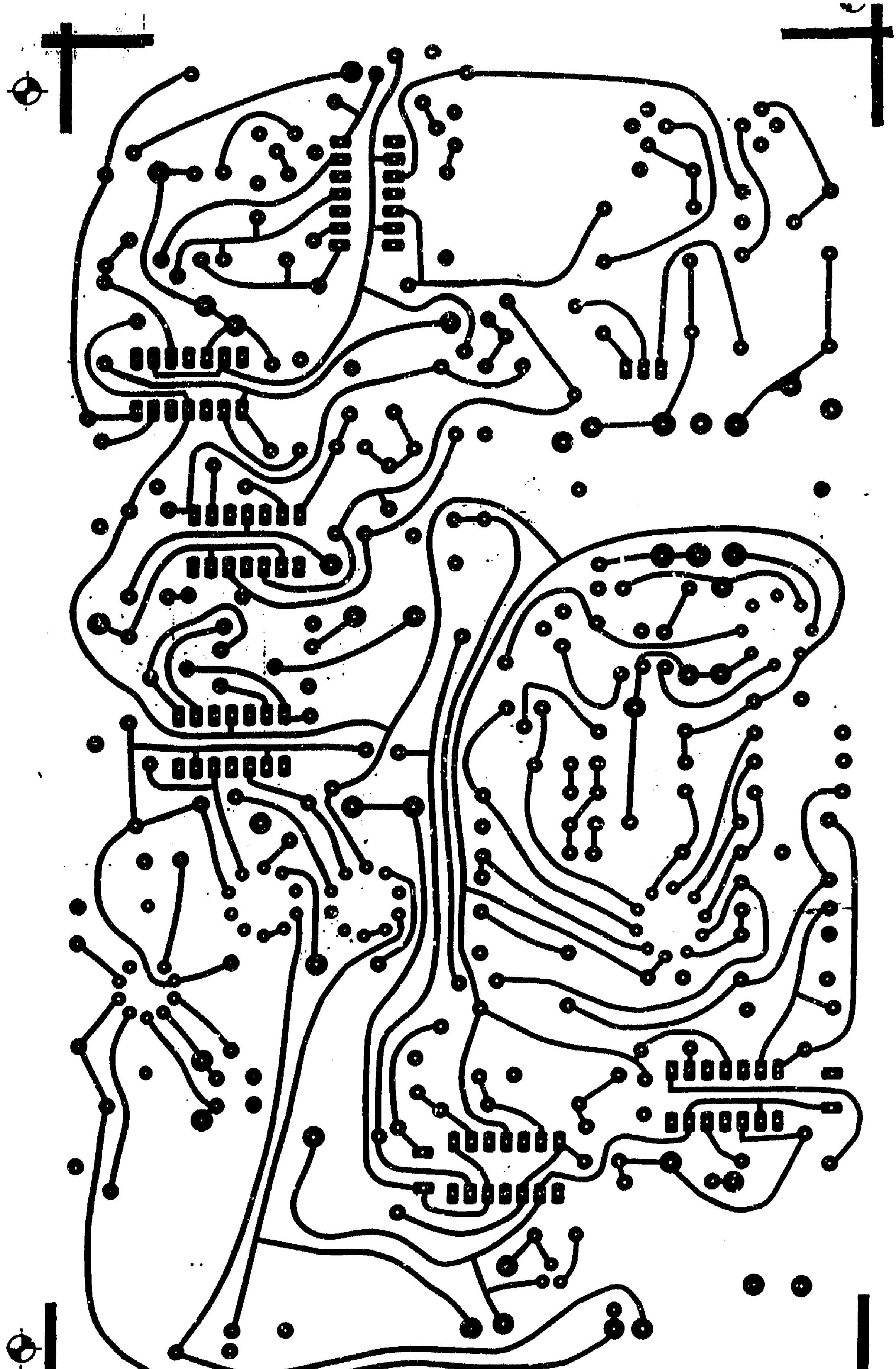
1- ALL BOARD STANDOFFS ARE DUAL TURRET SOLDER TERMINALS CAMBION PT 160-2042-02-01-00.

2- U1, U3, U4, U5, U7, AND U10 ARE CA3240AE1.

3- U6 IS UA725.

SYSTEMS INTEGRATION ENGINEERING

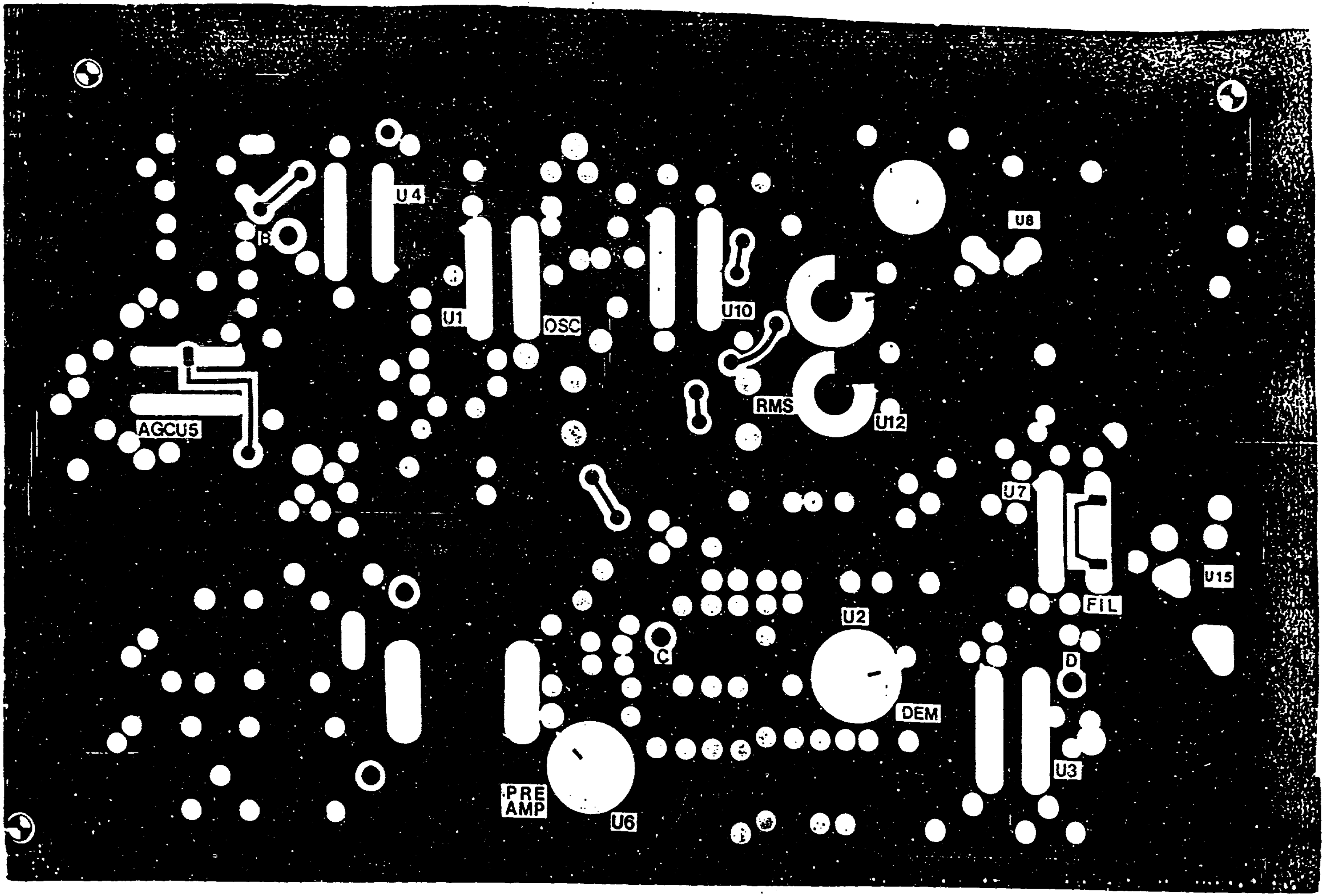
THERMOSONDE ELECTRONICS



SIE D-1000

THERMOSONDE ARTWORK

SIE D-1001



THERMOSONDE ARTWORK

SYSTEMS INTEGRATION ENGINEERING, INC.

CONTROL NO. C-0052-2	
DATE 1-7-87	
REV	PAGE 1 OF 3

THERMOSONDE BOARD INSPECTION AND CLEANING PROCEDURES

REV	ECO NO.	APPROVAL SIGNATURE	TITLE	DATE
		Ron B. Fowler	SYSTEMS ENGINEER	1/7/87

1.0 PURPOSE

This procedure is used to ensure that the thermosonde board is inspected and clean both during and after fabrication.

2.0 APPLICABLE DOCUMENTS

A. Thermosonde Assembly Procedure (C-0052-1)

3.0 REQUIREMENTS

3.1 EQUIPMENT

A. Illuminated Magnifier (X3)
B. Rosin and Flux Remover
C. Equipment Required for Thermosonde Assembly (See C-0052-1)
D. Water Flush
E. Alcohol Bath

3.2 NOTE

A. All visual inspections should be done using an illuminated magnifier.

3.3 PROCEDURES

A. INCOMING INSPECTION

A1. Unwrap board and clean in alcohol bath.
A2. Visually inspect drilled and ground plane areas for delamination.

B. FABRICATION (See Thermosonde Assembly Procedure C-0052-1)

B1. Install all test pins, cable standoffs and 'Z' bars.

B2. Clean board in a rosin and flux remover.

B3. Inspect all standoffs for a clean, solid connection to board. Check that all 'Z' bars are flush to board.

B4. Assemble all components to board (this includes jumper wires).

B5. Clean board in a bath of rosin and flux remover. Then flush with water.

B6. Inspect components for clean solder connections and flush mounting to board. Check that all ground plane connections are clean and solid.

B7. Install all cables and connectors.

C. TEST

C1. Perform thermosonde adjustment and calibration test (C-0052-7).

SYSTEMS INTEGRATION ENGINEERING, INC.

CONTROL NO.	C-0052-1
DATE	1-7-1987
REV	PAGE 1 OF 4

THERMOSONDE ASSEMBLY PROCEDURE

REV	ECO NO.	APPROVAL SIGNATURE	TITLE	DATE
		Roger B. Hurd	SYSTEM ENGINEER	1-7-1987

SYSTEMS INTEGRATION ENGINEERING, INC.

REV.												

THERMOSONDE ASSEMBLY PROCEDURE	CONTROL NO. C-0052-1
	DATE 1-7-87
	PAGE 2 of 4

1.0 PURPOSE

This procedure is used to supplement engineering drawings and to insure the fabrication of standardized highly reliable thermosonde circuit boards.

2.0 APPLICABLE DOCUMENTS

A. Thermosonde Board Parts List (attached)

B. Thermosonde Board Assembly Drawing 052-1003 (attached)

C. Thermosonde Electronic Schematic (attached)

3.0 REQUIREMENTS

3.1 Equipment

A. Solder Station

B. Flush Cut Pliers

C. Needle Nose Pliers

D. 60/40 Solder

E. Rosin Cleaner

F. 24 Gauge Unshielded Single Strand Wire

G. Components as listed on attached parts list

3.2 Notes

A. Maintain solder iron temperature of 500°-550°F.

B. All resistors should be flush mounted to board.

C. All capacitors and potentiometers should be flush mounted where possible, but in no case should be more than 3/16" off the Printed Circuit Board (PCB).

D. All "can" type integrated circuits and transistors should be mounted no more than 1/4" off the PCB.

E. All other type integrated circuits should be flush mounted to the board.

3.3 Procedure

A. Place and crimp the board standoffs to the PCB. Ensure that the standoff is pushed through the circuit side of the PCB.

B. Solder all standoffs in place on both sides of the PCB.

C. Place and solder 'Z' bars onto the PCB using 24 gauge wire.

D. Thoroughly clean and visually inspect the PCB.

E. Place and solder all resistors (except R55 and R64) onto the PCB in groups of 10. Make certain that all resistors with ground connections are soldered on both sides of the PCB. Flush cut resistor leads.

F. Place and solder all diodes onto the PCB. Make certain that all diodes with ground connections are soldered on both sides of the board. Flush cut diode leads.

G. Place and solder all ceramic capacitors to the PCB (except C36) in groups of 10. Ensure that all capacitors with ground connections are soldered on both sides of the board. Flush cut capacitor leads.

H. Wrap one lead of R53 around standoff. Cut excess leads and solder in place.

I. Wrap leads of R64 to standoffs and cut excess leads. Wrap leads of C36 to standoffs (ensure that both capacitor and resistor leads are in direct contact with the standoffs). Cut excess leads and solder leads to standoffs.

J. Bolt U8 into place. Ensure nylon washer is on circuit side of board. Solder and flush cut U8 leads.

K. Place and solder all can type IC's and transistors. Ensure all GND connections are soldered on both sides of the board Flush cut leads.

L. Install and solder all remaining capacitors. Check and ensure that all polarized capacitors are installed in the proper direction. Solder ground leads on both sides of the board. Flush cut leads.

M. Install remaining integrated circuits on the board. Insure that PIN 1 of each integrated circuit is installed in the proper location. Surface solder all integrated circuits with ground plane interconnections. Solder all integrated circuits in place.

N. Install all jumper wires. Solder and flush cut leads.

O Clean and visually inspect the board.

P. Install power cables, signal cable and probe leads to board standoffs. Ensure all cables are wrapped solidly around standoffs. Solder in place.

Q Perform a functional test on the thermosonde board.

SYSTEMS INTEGRATION ENGINEERING
THERMOSONDE PARTS LIST, NOV. 88

COMPONENT	DESCRIPTION			
R1	4.64K	1%	RN55C	
R2	121 OHM	1%	RN55C	REPLACES 121 OHM 5%
R3	10K	5%		
R4	10K	5%		
R5	2.74K	1%	RN55C	REPLACES 2.7K OHM 5%
R6	1K	5%		
R8	10K POT			
R10	47 OHM	3339 P-1-103 BOURNS		
R11	47 OHM			
R12	8.2K	5%		
R13	300 OHM	5%		
R14	20K	5%		
R15	1.5K	5%		
R16	10K	5%		
R17	1.5K	5%		
R18	475 OHM	5%		
R19	475 OHM	5%		
R20	5.1K	1%	RN55C	
R21	1.5K	1%	RN55C	
R22	1.5K	5%		
R23	470 OHM	5%		
R24	500K POT	3339-P-1-504	BOURNS	
R25	51K	5%		

SYSTEMS INTEGRATION ENGINEERING
THERMOSONDE PARTS LIST, NOV. 88

COMPONENT	DESCRIPTION		
R26	10K	5%	
R27	10K	5%	
R28	20K		
R29	10K		
R30	10K	5%	
R31	10K	5%	
R32	124K	1%	RN55C
R33	124K	1%	RN55C
R34	51K	1%	RN55C
R35	16K	1%	RN55C
R36	150K	5%	
R37	75K	5%	
R38	100K	5%	
R39	1M	5%	
R40	100K	5%	
R41	51K	5%	
R42	100K	5%	
R43	5K POT	3339 P-1-502 BOURNS	
R44	3K	5%	
R45	100K	5%	
R46	51K	5%	
R47	100K	5%	
R48	5K POT	3339 P-1-502 BOURNS	
R49	3K	5%	

SYSTEMS INTEGRATION ENGINEERING
THERMOSONDE PARTS LIST, NOV. 88

COMPONENT	DESCRIPTION			
R50	33K	5%		
R51	100K	5%		
R52	100K	5%		
R53	1.30K	1%	RN55C	
R57	100K	5%		
R58	1.30K	1%	RN55C	
R59	10K	1%	RN55C	
R60	1K POT	3250 W-1-102 BOURNS		
R61	10K	1%	RN55C	
R62	50 OHM POT	3339 P-1-500 BOURNS		
R63	20 OHM	1%	RN55C	REPLACES 20 OHM 5%
R64	60.4K	1%	RN55C	
R65	470 OHM	5%		
R66	4.22K	1%	RN55C	
R67	4.22K	1%	RN55C	
R68	10K	1%	RN55C	
R69	10K	1%	RN55C	
R70	100K	1%	RN55C	
R71	200K	1%	RN55C	
R72	100K	1%	RN55C	
R73	1M	1%	RN55C	
R74	75 OHM	5%		
R75	200K	1%	RN55C	
R76	1M	1%	RN55C	

SYSTEMS INTEGRATION ENGINEERING
THERMOSONDE PARTS LIST, NOV. 88

COMPONENT		DESCRIPTION	
R82	3.0 OHM	5%	NEW PART
R83	3.0 OHM	5%	NEW PART
R93	5K	5%	NEW PART
C1	0.047uF	MALLORY 473K02PE590L1 (POLY. FILM)	
C2	0.047uF	MALLORY 473K02PE590L1 (POLY. FILM)	
C3	0.047uF	CENTRALLAB CK05BX473	
C4	47uF	MALLORY MTP476M020P1B (MIL-STD-202)	
C5	47uF	MALLORY MTP476M020P1B (MIL-STD-202)	
C6	0.047uF	CK05BX473	
C7	0.047uF	CK05BX473	
C8	0.47uF	CK05BX474	
C9	0.47uF	CK05BX474	
C10	0.47uF	CK05BX474	
C11	0.1uF	CK05BX104K 10% CERAMIC	
C12	0.1uF	CK05BX104K 10% CERAMIC	
C14	10uF	CL23BE100UNE	
C15	2700pf	CK05BX272K	
C16	0.1uF	CK05BX104K	
C17	0.047uF	CK05BX473	
C18	0.1uF	CK05BX104K	
C19	0.1uF	CK05BX104K	
C20	0.01uF	CK05BX103K	
C23	0.01uF	CK05BX103K	

SYSTEMS INTEGRATION ENGINEERING
THERMOSONDE PARTS LIST, NOV. 88

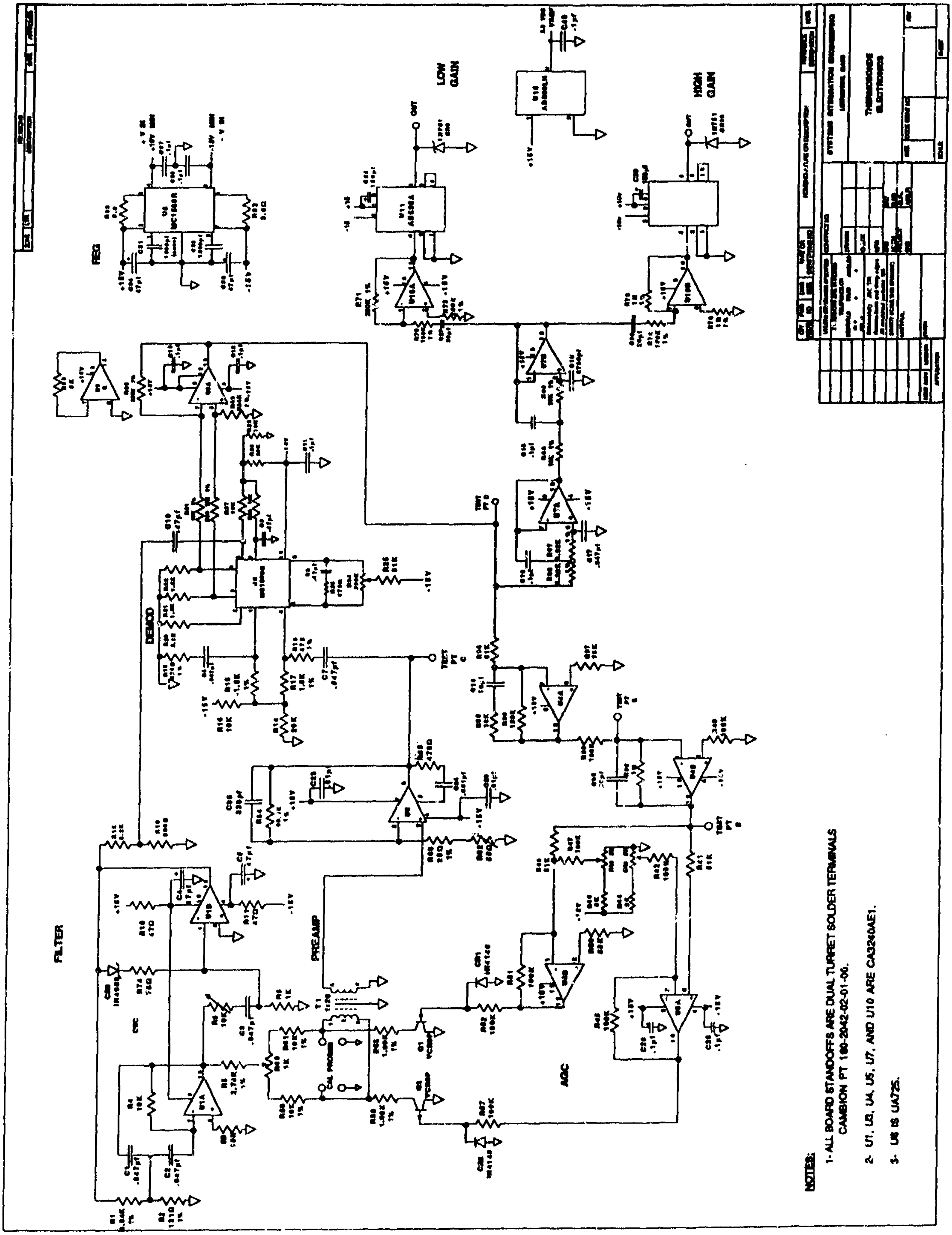
COMPONENT		DESCRIPTION	
C24	0.001uF	CK05BX102K	
C25	0.1uF	CK05BX104K	
C26	0.1uF	CK05BX104K	
C27	20uF	SPRAGUE CL 23BG200UNE	
C28	150uF	MALLORY CMT157M020P1C 20V	
C29	20uF	SPRAGUE CL23BG200UNE	
C30	150uF	MALLORY CMT157M020P1C 20V	
C31	1500pF	CK05BX152K	
C32	1500pF	CK05BX152K	
C33	47uF	MALLORY MTP476M020P1B	
C34	47uF	MALLORY MTP476M020P1B	
C35	20uF	SPRAGUE CL23BG200UNE	
C36	330pF	CK05BX331K	
C37	0.1uF	CK05BX104K	
C38	0.1uF	CK05BX104K	
C40	0.1uF	CK05BX104K	
T1	TRANSFORMER, TRANEX #20344		
CR1	1N4148		
CR2	1N4148		
CR3	1N4689		REPLACES 1N751
CR9	1N751 NEW PART		
CR10	1N751 NEWPART		

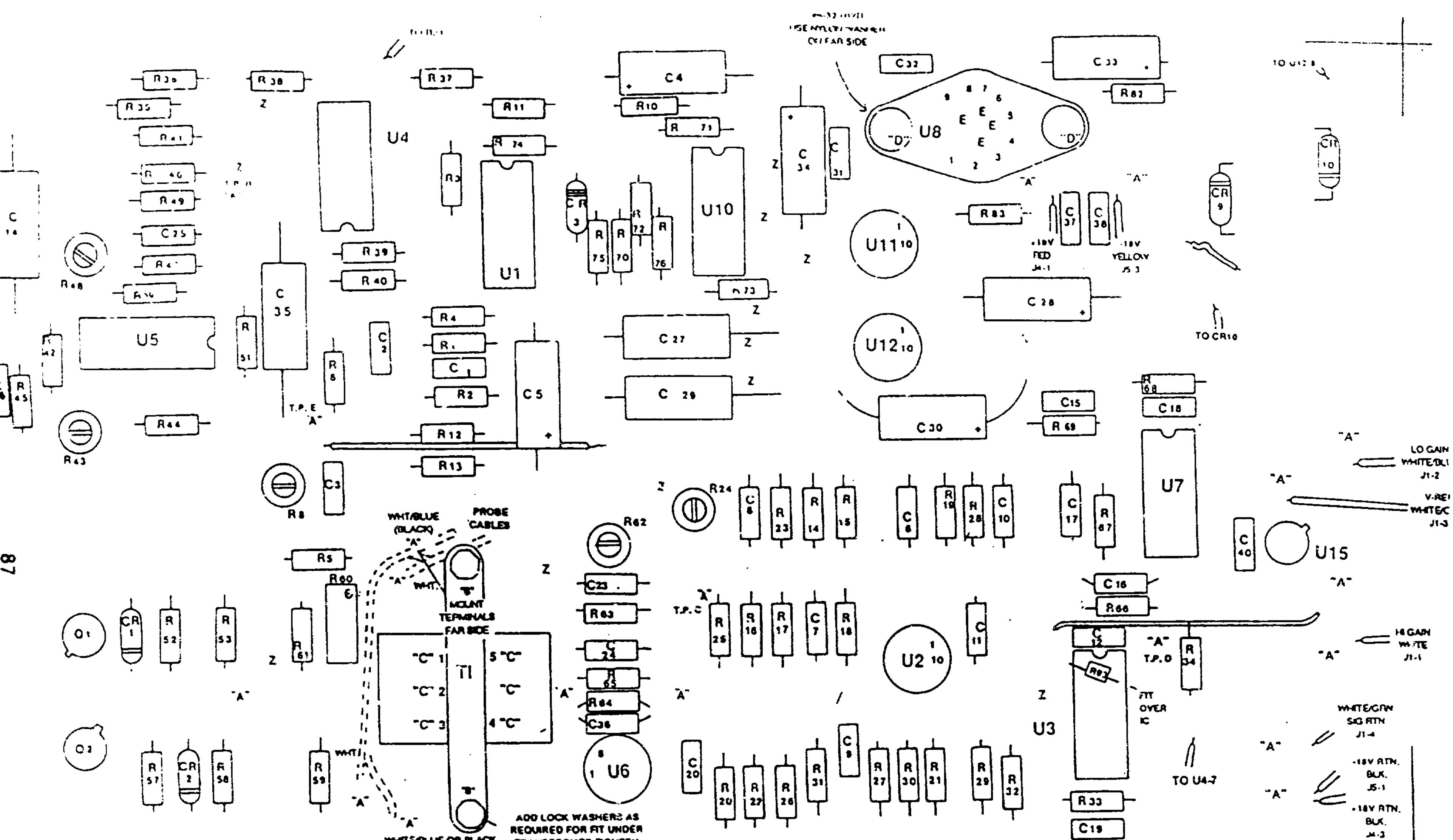
SYSTEMS INTEGRATION ENGINEERING
THERMOSONDE PARTS LIST, NOV. 88

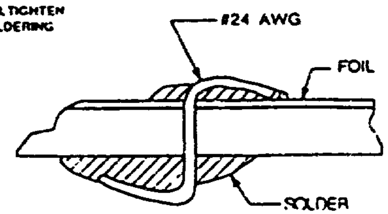
COMPONENT	DESCRIPTION
Q1	VCR3P
Q2	VCR3P
U1	CA3240AE1
U2	MC1596G
U3	CA3240AE1
U4	CA3240AE1
U5	CA3240AE1
U6	UA725HM
U7	CA3240AE1
U8	MC1568R
U9	NOT USED
U10	CA3240AE1
U11	AD536ASH
U12	AD536ASH
U15	AD58OLH

SYSTEMS INTEGRATION ENGINEERING
THERMOSONDE PARTS LIST, NOV. 88

COMPONENT	DESCRIPTION
PROBE CAB A	39 TO 40 INCHES RAYCHEM P/N 44/2421-24-9/0-9
PROBE CAB B	39 TO 40 INCHES RAYCHEM P/N 44/2421-24-9/0-9
POWER CAB +	12 INCHES RED & BLACK TWISTED PAIR #24 AWG
POWER CAB -	12 INCHES YEL & BLACK TWISTED PAIR #24 AWG
SIG. CABLE	12 INCHES RAYCHEM P/N 44AM/1141-24-1/4/5/6-9
POW. CONN.	2 EACH MOLEX 03-09-2032
SIG. CONN.	1 EACH MOLEX 03-06-1056 & 03-06-2055
TERMINAL	22 EACH CTC 160-2042-02-01-00
BEAD	8 EACH FAIR RITE P/N 2643000801
HOUSING 1	1 TOP, 1 BOTTOM PER DWG LKD 83-1058D
SHIELD	5 MIL ALUMINUM SHEET STOCK (SEE NOTES)
CROSS BOOM	1 EACH PER DWG LKD 83-1058D
PROBE	2 EACH PER DWG GL83-020C (REV A)
PROBE HSG	2 EACH PER DWG GL82-008C (REV A)
GND WIRE	4 INCHES AWG #22, SOLID INSULATED


FILTER
PREAMP
AGC
DEMOD
REG
LOW GAIN
HIGH GAIN
NOTES:
1- ALL BOARD STANDOFFS ARE DUAL TURRET SOLDER TERMINALS CAMBION PT 180-2042-02-01-00.
2- U1, U3, U4, U5, U7, AND U10 ARE CA3240AE1.
3- U8 IS UA725.





NOTES:

1. MAT'L .062 THK EPOGLASS PER MIL-P-134915 GF
2. FOR SCHEMATIC SEE 052-1001
3. ALL HOLES .031 UNLESS NOTED. "A" HOLE .072 DIA. INSTALL CTC TERMINAL 160-2042-02-01-00
   "B" HOLES .125 DIA. "C" HOLES .052 DIA.
   "D" HOLES .152 DIA. "E" HOLES .035 DIA.
4. PARTS LIST, NOV. 86, 7 SHEETS
5. SHRINK TUBING MUST COVER THE CUT WHERE THE SHIELD OF ALL THE SIGNAL CABLES HAS BEEN EXPOSED NEAR BOARD

THERMOSONDE BOARD ASSEMBLY
SYSTEMS INTEGRATION ENGINEERING
052-1003
SCALE 2/1

SYSTEMS INTEGRATION ENGINEERING, INC.

	CONTROL NO. C-0052-3
	DATE 1-7-87
	REV | PAGE 1 OF 3

FINE WIRE PROBE

CABLE ASSEMBLY

PROCEDURES

REV	ECO NO.	APPROVAL SIGNATURE	TITLE	DATE
		[signature]	SYSTEMS ENGINEER	1/7/87

1.0 PURPOSE

Fabricate cable to carry signal from the fine wire probes to the thermosonde board.

2.0 REQUIREMENTS

2.1 EQUIPMENT

A. Solder Station
B. Wire Cutter
C. Heat Gun
D. X-acto Knife
E. 60/40 Solder
F. Needle Nose Pliers
G. Wire Strippers

2.2 MATERIALS

A. Cable (Raychem 44/2421-24-019-9)
B. Connectors Pins (From Sealectro 027-6005-00-0-179)
C. Ferrite Beads
D. Ground Wire 24 AWG, Multistrand (Black), 3.5 inches
E. Heat Shrink 3/16" I.D.

2.3 PROCEDURES

A. Cut the cable to 39" length
B. From one end strip 3" of outer insulation (be careful not to cut shield). Insulation can be removed from the cable by cutting a ring around the insulation with an x-acto knife, then heating that end with a heat gun for 3-5 seconds. Once heated, quickly pull the insulation off the cable.

C. Pull shield back over outer insulation and cut to 3/8" length.

D. Solder one end of ground wire to shield.

E. Shrink 3/4" of 3/16" I.D. heat shrink over solder connection making certain that the entire ground shield is covered.

F. Strip and tin 1/4" of all wires.

G. Place 4 ferrite beads over two cable lead. (not over ground lead)

H. Twist and solder shield lead to (blue/white) wire.

I. On the other end of the cable, cut and strip 1" of the outer insulation and shield being careful not to cut the inner wires.

J. Strip and tin 1/4" of each wire, then cut back to 1/8".

K. Place a connector pin over each wire snug to insulation and heat without solder to attach the connector to the wire. The connector pins fit snugly to the wire. Care should be exercised to ensure that no excess solder was used in step F.

SYSTEMS INTEGRATION ENGINEERING, INC.

CONTROL NO. C-0052-5	
DATE 1-7-87	
REV	PAGE 1 OF 3

THERMOSONDE SIGNAL
CABLE ASSEMBLY
PROCEDURES

REV	ECO NO.	APPROVAL SIGNATURE	TITLE	DATE
		Roger B. Sandel	SYSTEMS ENGINEER	1/7/87

1.0 PURPOSE

Fabricate cable to carry signal from thermosonde board to the radiosonde cable.

2.0 REQUIREMENTS

2.1 EQUIPMENT

A. Solder Station
B. 60/40 Solder
C. Diagonal Wire Cutters
D. Needle Nose Pliers
E. Heat Gun
F. X-acto Knife
G. Wire Strippers
H. Crimping Tool

2.2 MATERIALS

A. Cable - Raychem 44AM1141-24-9/93/95/96-9
B. Connectors - Molex 03-06-1056
C. Connector Pins - Molex 02-06-2132
D. Heat Shrink 3/16" I.D., 1/8" I.D.

2.3 PROCEDURES

A. Cut the cable to 12" length
B. Remove 1 1/2" of insulation from each end of the cable. Insulation can be removed from the cable by cutting a ring around the insulation with an x-acto knife, then heating that end with a heat gun for 3-5 seconds. Once heated, quickly pull the insulation off the cable.

C. Unravel shield from one end and twist. Remove shield completely from the other end.

D. Strip and tin 1/4" of all leads.

E. Crimp connector pins on all leads at shield lead end of cable including shield lead. Solder all crimp connections.

F. Shrink 1 1/8" of 1/8" I.D. heat shrink over shield lead.

G. Insert connector pins into the connector. (From pointed side: white; white/blue; white/orange; white/green; shield)

H. Shrink 1" of 3/16" I.D. heat shrink over all the leads at the connector end of the cable and 1/2" over all leads at the opposite end. Heat shrink should be half over insulation and half over leads.

SYSTEMS INTEGRATION ENGINEERING, INC.

CONTROL NO. C-0052-4	
DATE 1-7-87	
REV	PAGE 1 OF 3

RADIOSONDE SIGNAL CABLE ASSEMBLY

REV	ECO NO.	APPROVAL SIGNATURE	TITLE	DATE
		Roger B. [illegible]	SYSTEMS ENGINEER	1/7/87

1.0 PURPOSE

Fabricate cable to carry signal from thermosonde cable to radiosonde.

2.0 REQUIREMENTS

2.1 EQUIPMENT

A. Solder Station
B. 60/40 Solder
C. Diagonal Wire Cutters
D. Needle Nose Pliers
E. Heat Gun
F. X-acto Knife
G. Wire Strippers
H. Crimping Tool

2.2 MATERIALS

A. Cable - Raychem 44AM1141-24-9/93/95/96-9
B. Connectors - Molex 03-06-2055
C. Connector Pins - Molex 02-06-1132
D. Heat Shrink 3/16" I.D. and 1/8" I.D.
E. 24 AWG Multistrand Wire (Black)

2.3 PROCEDURES

A. Cut the cable to 12" length
B. Remove 1 1/2" of insulation from each end of the cable. Insulation can be removed from the cable by cutting a ring around the insulation with an x-acto knife, then heating that end with a heat gun for 3-5 seconds. Once heated, quickly pull the insulation off the cable.

C. Unravel shield from one end and twist. Cut shield down to 3/8" on the opposite end.

D. Strip and tin 1/4" of all leads.

E. Cut a 1 3/4" length of 24 AWG wire. Strip and tin 1/4" from each end of this wire.

F. Push 3/8" of the cable shield back over the cable insulation and solder one end of the 1 3/4" length of wire to the cable shield.

G. Crimp connector pins on all the leads at the twisted shield end of the cable including shield lead. Solder all crimp connections.

H. Shrink 1 1/8" of 1/8" I.D. heat shrink over the shield lead.

I. Insert pinned leads into the molex connector. (From pointed side: white; white/blue; white/orange; white/green; shield).

J. Shrink 1" of 3/16" I.D. heat shrink over all leads at the connector end of the cable and 3/4" over solder joint at the opposite end. Heat shrink should be half over insulation and half over leads.

SYSTEMS INTEGRATION ENGINEERING, INC.

CONTROL NO.	C-0052-5
DATE	1-7-87
REV	PAGE 1 OF 5

THERMOSONDE ADJUSTMENT AND CALIBRATION PROCEDURE

REV	ECO NO.	APPROVAL SIGNATURE	TITLE	DATE
		Roger B. Sowele	SYSTEMS ENGINEER	1/7/87

1.0 PURPOSE

Thermosonde adjustment and calibration to ready the unit for flight measurements.

2.0 REQUIREMENTS

2.1 EQUIPMENT

A. Dual Output 18 VDC Floating Battery Pack
B. Dual Trace Oscilloscope
C. Digital Voltmeter
D. Thermosonde Calibration Box
E. Assorted Cables and Connectors
F. Hand Tools

2.2 PROCEDURES

A. Inspect the thermosonde board for damage, broken wires, cleanliness, bad solder joints, etc.

B. Connect the calibration box to the thermosonde. RES switch should be ON, all other switches should be in the OFF position.

C. Connect the battery box (power off) to the thermosonde.

D. Turn on battery pack power. Current on each output of the battery pack should be no greater than 100 mA.

E. Using the digital voltmeter, measure the outputs of the voltage regulator U8. The voltages should be:

1. $+ 15 \pm .75$ volts at the junction of pin 2 of U8 and C34.
2. $- 15 \pm .75$ volts at the junction of pin 7 of U8 and C33.

F. Connect the oscilloscope as follows: Channel 1 to pin 10 of U1, channel 2 to pin 12 of U1, AC coupling for both. Trigger internally on channel 2. On channel 1, a sine wave of approximately 3 KHZ and greater than 6V P-P should be observed. On channel 2, a aquare wave should be observed with approximately the same values.

G With both signals on the scope, adjust R8 until the signals are 180° out of phase.

H. Connect clip lead across C35 (between test points B and E). Turn R43 and R48 fully clockwise (10 turns). Turn R62 fully clockwise and then turn back 5 turns.

I. Connect the oscilloscope to test point C. The predominant signal at this point should be a 3 KHZ sine wave. Some distortion due to a small amount of noise and higher frequency components may be present. Adjust R60 to decrease the sine wave amplitude to 50 mV or less.

J. Connect the oscilloscope to test point D. Adjust R24 until the negative peaks of the demodulated 3 KHZ signal are of the same amplitude. The wave forms at this point are a series of half sine waves between their 90° and 270° points, interrupted by switching transients.

K. Connect a digital voltmeter to test point D. Re-adjust R60 to reduce the DC voltage to between ± 75 mV.

L. Connect the digital voltmeter to the cathode of CR1 and the oscilloscope to test point C. Turn R48 counter clockwise while observing the digital voltmeter and the oscilloscope. As Q1 starts to turn on, the 3 KHZ wave at test point C will begin to increase. The voltage at the cathode of CR1 will be approximately 4 VDC. Turn R48 clockwise for an additional .5V. Attach the digital voltmeter to the cathode of CR2 and adjust R43 in the same manner.

After these adjustments, the voltages of CR1 and CR2 should be within .5 volts of each other. If they are not within .5 volts of each other, replace CR1 or CR2 and repeat step L until a matched pair is created.

M. Remove the short from C35. Allow time (no more than 2 minutes) for the circuits to reach a steady state. Using the digital voltmeter, check the output voltages. The DC signal at the Lo-gain output should be less than 100 mV. Typical readings are in the vicinity of 50 mV. The signal at the Hi-gain output should be less than 300 mV. Typical readings are in the vicinity of 200 mV.

N. Turn on the oscillator in the calibration box by moving the OSC switch into the UP position. Move R8 and R12 switches into ON positions. Adjust R62 to produce 3.90 volts at the Lo-gain output.

O Turn the oscillator, R8 and R12 in the calibration box OFF. Allow time (no more than 2 minutes) for the circuits to settle. Verify the quiescent readings of step M. Then turn the oscillator, R8 and R12 ON. The Lo-gain output should return to 3.90 volts within 60 seconds.

P. Proceed with the calibration by throwing the appropriate switches ON and OFF as required by the attached "Laboratory Thermosonde Calibration" sheet. Allow at least 60 seconds after each disturbance before recording results.

Q Measure and record to a ± 1 mV accuracy, the voltage ($V_{Ref.}$) from the stand off, for the WH/OR wire. $V_{Ref.}$ should read 2.5 ± .1 VDC.

LABORATORY THERMOSONDE CALIBRATION

DATE: ________

MICROSONDE S/N: ________________ V REF: ________
THERMOSONDE S/N: ________________ Rp1= ________
PROBE PAIR: ________________ Rp2= ________

SIMULATED PROBES

Rp= 27.5

ACTUAL PROBES

Rp AVG= ______

LO GAIN		HI GAIN	
R#	RMS volts		RMS volts
R 0		R 0	
R 2		R 1	
R 3/2		R 2	
R 4/2		R 3	
R 7		R 3/2	
R 8		R 4	
R 9		R 4/2	
R 10		R 5	
R 11		R 5/2	
R 12		R 6	
R 12/4/2		R 7	
R 12/7		-	
R 12/8		-	

SYSTEMS INTEGRATION ENGINEERING, INC.

	CONTROL NO. C-0052-6
	DATE 1-7-87
	REV / PAGE 1 OF 3

THERMOSONDE PROBE BALANCING PROCEDURE

REV	ECO NO.	APPROVAL SIGNATURE	TITLE	DATE
		Roger B. [illegible]	SYSTEMS ENGINEER	1/7/87

SYSTEMS INTEGRATION ENGINEERING, INC.

REV.												

Thermosonde Probe Balancing Procedure	CONTROL NO. C-0052-6 DATE 1-7-87 PAGE 2 of 3

1.0 PURPOSE

To balance a pair of fine wire probes with a thermosonde board.

2.0 REQUIREMENTS

2.1 EQUIPMENT

A. Dual Output 18 VDC Floating Battery Pack

B. Digital Voltmeter

C. Thermosonde battery box or any other small box capable of enclosing a pair of fine wire probes.

D. Adjusting Tool

E. Assorted Cables

2.2 PROCEDURES

A. Clip fine wire probe leads to 1/4" and 5/16" Spread leads slightly to prevent shorting. Remove probe caps and attach to thermosonde cables. Replace the probe caps.

B. Tape probes tightly together and place the pair inside an enclosed box.

C. With power off, connect the battery pack to the thermosonde.

D. Allow 10-15 minutes for probe temperature to stabilize.

E. Attach the digital voltmeter to test point D of the thermosonde.

F. Apply power to the thermosonde. The digital voltmeter should register a switch on voltage which gradually decreases toward zero.

G. Place a shorting cable across C35 between test point B and test point E.

SYSTEMS INTEGRATION ENGINEERING, INC.

REV.												

Thermosonde Probe Balancing Procedure	CONTROL NO. C-0052-6 DATE 1-7-87 PAGE 3 of 3

H. Adjust R60 until the digital voltmeter registers less than .075 VDC. If R60 will not adjust voltage to desired level, check probe connections for opens or shorts. If none are found, check probe resistances (nominal probe resistance is 27 ohms). If voltage "walks" allow more time for the probe temperatures to stabilize.

I. Remove shorting lead from C35.

J. Check voltage at Lo-gain output. It should stabilize to 100 mV or less within one minute.

K. Turn power off, and remove digital voltmeter and battery cables.

L. Remove probes from the box. Tape probes to thermosonde housing.